REPORT OF THE NATIONAL CONFERENCE ON TECHNOLOGY UTILIZATION AND ECONOMIC GROWTH

JULY 30 THROUGH AUGUST 4, 1967

Edited by:

. W. MULLIS

AEROSPACE RESEARCH APPLICATIONS CENTER

REPORT OF THE NATIONAL CONFERENCE

ON TECHNOLOGY UTILIZATION

AND

ECONOMIC GROWTH

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Edited By
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Foreword

Since the establishment of the National Aeronautics and Space Administration in 1958, an ever increasing attention has been focused on the relationship between the rate of utilization of already developed technology and the rate of national economic growth. The National Conference on Technology Utilization and Economic Growth was an effort to bring together expert opinions and obtain critical reflections on this relationship. In convening the Conference, the Aerospace Research Applications Center was guided by the following work statement from NASA Contract number NSR - 003 - 055:

> ". . .conduct a summer institute for technology utilization to acquaint potential users with technology utilization, to transmit to those attending current information on services, techniques, organizations, philosophy, and programs in this area, and to analyze and evaluate the findings of current research in the technology utilization area;. . ."

Consistent with its mission, the Office of State Technical Services, Department of Commerce participated in the financial support of the Conference as a special merit program.

This report is in no way an effort to provide a transcription of the Conference. Where manuscripts were available, they have been incorporated in their entirety. Where the manuscripts were not available, the editor has summarized the essence of the remarks from recordings made during the Conference. These summaries were then reviewed by members of the session. I want to especially thank Richard Bailey for preparation of Session No. 3, Economic Growth Studies and David W. Cravens for preparation of Session No. 6, Research on Transfer of Technology. Appreciation is also expressed to the following reviewers for their prompt support and many helpful suggestions: Technology Utilization and Economic Growth: An Overview, Arthur M. Weimer; The Role of the Business School, Paul V. Grambsh; The Role of the Engineering School, Harold M. DeGroff; Urban Administration Lyle C. Fitch, The Role of Federal Government Programs, George J. Howick; Financial Institutions, E. E. Edwards; The Role of Research Institutes, James Alcott; The Role of Business Firms, Joseph DiSalvo; The Impact of NASA R&D Programs on Management and Economic Growth, John F. Mee; Education Needs in Technology Utilization, Richard L. Lesher; The Role of the Medical Sciences, Harrison Shull.

A special recognition is extended to Mrs. Jerilyn Kennedy who transcribed the tapes; and to Mrs. Libby Rader who typed the drafts for review and the final masters. Their cheerful attitude toward the task made the editor's job much easier than it might have been.

Credit must go to Arthur Weimer for his creative conception of the Conference agenda and the effective organization of the program. The session chairmen are to be lauded for the stimulating sessions and informative discussions which transpired. It was the exceptional contributions of the participants and attendees which caused the Conference to be rated a success.

Charles W. Mullis

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WELCOMING REMARKS

Elvis J. Stahr

President
Indiana University

WELCOME BY DR. STAHR

I am very happy to welcome all of you to our National Conference on Technology Utilization and Economic Growth. The University has been concerned with economic growth for a good many years, and has participated in many kinds of programs in this general area, nationally as well as regionally in the State of Indiana. But our interest in technology utilization has developed in more recent years, and we have given special attention to this area through the work of the Aerospace Research Applications Center, which is now moving into its fifth year of operation. ARAC, as we call it for short - as most of you know - is the local sponsor of this Conference which undertakes to bring together these two broad subjects of technology utilization and economic growth.

This is indeed a multi-disciplinary problem. The program itself reflects the broad range of subjects involved. In the past, technology utilization has been primarily of concern in such areas as manufacturing and related production activities. But we now see significant applications of technology in many other areas in the field of financial institutions, the medical sciences, urban administration and quite a few more. I hope all of you will benefit greatly by your participation in the Conference. I know the University will benefit from it.

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The remainder of Dr. Stahr's comments was devoted to the presentation of Distinguished Service Awards to Dr. Howard L. Timms and Dr. David W. Cravens, who pioneered in the establishment and development of the Aerospace Research Applications Center.

SESSION NO. 1

TECHNOLOGY UTILIZATION AND ECONOMIC GROWTH: AN OVERVIEW

Moderator:
Arthur M. Weimer
Vice Chairman, Aerospace Research Applications Center
Indiana University

Panelists:
Gerhard Colm
Chief Economist, National Planning Association

Edward F. Dennison
The Brookings Institution

Robert C. Turner
Distinguished Service Professor
Indiana University

George W. Wilson
Chairman, Department of Economics
Indiana University

INTRODUCTION

Dr. Weimer introduced representatives of the sponsoring agencies: Dr. Joseph DiSalvo, Director, ARAC; General Jacob Smart, Assistant Administrator for Policy Analysis, NASA; and Dr. Paul J. Grogan, Director, Office of State Technical Services, United States Department of Commerce. He further pointed out that additional financial support was provided by the Indiana University Foundation. He then introduced the first session, pointing out that the Conference was oriented toward the general subject of economic growth with each session having relation to this central topic. Among the sources of economic growth, technology ranks high and the utilization of technology plays a major role he said.

SUMMARY OF REMARKS BY ROBERT C. TURNER

Economic growth means in essence the growth of the real output of the Nation. There are some problems of measurement of the growth of real output. Gross National Product (GNP) and Net National Product (NNP) were defined and GNP was selected as the measure. The problems of adjustment for price increases were identified. Growth in GNP was defined as a function of three variables: the number of persons involved in production, the number of hours per person and the productivity per man hour. The determinants of change in each variable were discussed.

The determinants of change in productivity were identified as technology, education, availability of capital, etc. Productivity increased was identified as the type of growth that increases the standard of living. It was further established that historically, something like 2/3's to 3/4's of our economic growth has come from increasing output per man hour, and 1/4 to 1/3 has come from increasing the man hour input.

The validity of use of long historical periods for projection was challenged: ". . .It seems to me the tremendous changes that have taken place in the past generation or so have been so important, it doesn't help very much to go back of World War II. . .Since World War II, we have in this country experienced a growth rate something in the neighborhood of 3.8% depending on which beginning and ending year you take. . . of which about 3/4 is attributable to increased output per man hour and only 1/2 attributable to increased man hour input. So I see our assignment today as to identify what the origins of economic growth are, to make some estimates as to how they are likely to work out in the next decade or two, and in particular to see the role of technology in this growth process or others likely to produce economic growth in the fashion that it has in the past; and then one step beyond that to see what we can do to facilitate that process. . ."

TECHNOLOGY UTILIZATION AND ECONOMIC GROWTH

Notes Prepared by

Gerhard Colm

We are living in an area of technological revolution, but the technological revolution will have only an evolutionary impact on economic growth.

Technological mass unemployment <u>need</u> not be the consequence of the technological revolution. Also, the rate of economic growth can be expected to be higher than in the historical past but less than it was in the period 1961-1965.

I. Manpower: Redundance or Scarcity?

Modern technology need not result in permanent mass unemployment withing a forseeable period of time if the nation pursues vigorously and persistently its national goals. During the last 20 years the new technological revolution has created more job opportunities than were destroyed by replacement of men by machines. This is likely to continue for at least a decade or two but not necessarily for the indefinite future. There have been, and are likely to be, severe adjustment problems for a minority of people who, for a variety of reasons, do not meet job requirements of the technological age.

II. Technology and Productivity

Increase in productivity is the main factor determining the potential growth rate. Productivity, measured by private GNP divided by man-hours worked, is likely to rise faster in the next decade than the long-term average of the past but slower than in the 1960-1965 period.

Average Annual Rates of Growth, 1900-1975

Period	GNP a/	GNP b/	Labor Productivity b/	Man-hours b/
1900-1960	3.0	2.8	2.0	0.8
1960-1965	4.7	4.9	3.6 c/	1.3
1965-1975*	4.5	4.7	3.3 c/	1.4

* Projected

a/ GNP for total economy, constant dollars.

b/ Figures based on private economy.

c/ Adjustment made for recent official increase in productivity indes for the year 1965. (Manpower Report of the President, 1967)

NOTE: Estimates for the private sector are given to achieve comparability with Department of Commerce estimates. We assume productivity in government develops roughly similarly to that in the private sector; therefore, our projection for the private sector may well be regarded as reflecting the probable development for the economy as a whole.

Source: National Economic Projections to 1976/77, Report No. 66-N-1, Planning Association.

Table 1

Employment by Occupation Group, 1900 - 1975
Annual Rates of Change

Occupational Group	1900-1950	1950-1965	Projected 1965-1975
TOTAL	1.4	1.4	1.9
Professional	2.9	3.8	4.3
Managers, officials, proprietors	2.3	2.4	2.2
Clerical	4.2	3.0	2.3
Sales	2.3	0.9	1.3
Craftsmen	2.0	0.6	1.7
Operatives	2.4	0.2	1.1
Services, except private household	3.1	2.8	3.1
Private households	- 0.1	2.6	2.6
Industrial laborers	0.2	0.2	- 0.2
Farm workers	- 0.9	- 3.2	- 2.7

Sources: 1900-1950: David Kaplan and M. Claire Casey, Occupational Trends in the United States, 1900-1950. Census Working Paper No. 5 (Washington, D. C.: Department of Commerce).
1950-1975: National Economic Projections to 1976/77, Report No. 66-N-1, National Planning Association, Table 10 and above.

Table 2

Employment by Selected Industries, 1900-1975
Average Annual Rates of Increase

Item	1900-1929	1929-1957	1957-1965	Projected 1965-1975
Civilian economy	1.9	1.1	1.3	1.9
General government	3.6	3.3	3.8	3.4
Private economy	1.9	1.0	0.9	1.6
Farm	0.0	- 1.8	- 3.3	- 3.1
Nonfarm	2.6	1.5	1.6	2.1
Mining	1.6	- 0.8	- 3.5	- 2.3
Construction	2.0	2.1	1.1	2.8
Manufacturing	2.3	1.7	0.6	1.8
Trade	3.5	1.8	1.5	1.3
Finance, insurance, real estate	5.4	2.0	2.5	2.6
Transportation, communications, public utilities	2.3	0.3	- 0.8	- 0.9
Services */	2.5	1.2	3.5	2.9
Government enterprise	4.1	2.8	2.7	3.8

*/ Except private households.

Sources: 1900-1957: John W. Kendrick, Productivity Trends in the United States (National Bureau of Economic Research: Princeton University Press, 1961).
1957-1975: National Economic Projections to 1976/77, Report No. 66-N-1, National Planning Association, Table 9.

The increase in labor productivity will be higher because of the effect of automation and other inventions but also because of the reduced time lag between invention and innovation. It will be lower than in the recent period of expansion because in that period the cyclical effect of moving from a low to a high rate of operation of plant and equipment was superimposed on the long-term trend of gradually rising productivity.

The expected increase in productivity is, however, not revolutionary for the following reasons:

(1) Many improvements and new products or services are not reflected in statistical measurement of productivity.
(2) Computers and other technological equipment have an effect on inventories and effective use of capital equipment, which is not directly reflected in labor productivity as conventionally measured.
(3) There is still a considerable time lag between adoption of an innovation by a few firms and its spreading throughout the industry.
(4) Adoption of innovations is slowed down by costs for severance pay, retraining, etc., for displaced workers.

(5) Technological advances sometimes lead to additional costs, for instances, for air and water pollution control.

(6) In the past, reduction in the hours of work was associated with rising productivity. It is doubtful that the same effect will result from further reduction in hours of work.

(7) In the course of technological advances, the product mix changes in a manner which may result in a slowdown of average productivity increases.

   (a) In the past, agriculture has contributed to an extraordinary increase in over-all productivity, indirectly by the shift of agricultural workers to higher productivity in manufacturing industries, and secondly by the high productivity increase in the agricultural sector itself. With the reduction in the relative importance of agriculture these factors will become of diminishing importance in the future.

   (b) With rising income there is a shift of demand to services, some of which have limited possibility for technological advancement.

   (c) With increasing income there is a shift from mass-produced products to labor-intensive, handcrafted articles.

Thus, there is a built-in mechanism by which a more rapid increase in productivity creates its own countervailing forces.

Most of these factors are not subject to measurement even for past performance, much less for projection into the future. There is, nevertheless, a pretty firm basis for the judgment that productivity and thereby potential economic growth will increase above performance of the past but below that of the recent period of expansion.

SUMMARY OF REMARKS BY EDWARD F. DENISON

Dr. Denison discussed growth in terms of Net National Product (NNP) as defined by Dr. Turner. The difficulty, from a policy guidance standpoint, of establishing cause-effect relationships was pointed out. Sources of growth in the United States during the period 1929 to 1957 were identified as: number employed; reduction in hours of work per man; increased productivity; education; shifts in labor force (decrease in child labor, more women, etc.); increased capital; advances in knowledge (technical, economic and public policy) and economies of scale. Unfortunately, there seems not to be any way to measure advances in knowledge directly. Dr. Denison reported his efforts to measure the other variables and treat the residual as the contribution of advances in knowledge--recognizing the error potential. In this context then, advances in knowledge include managerial and organizational improvements as well as technological knowledge.

The second of Dr. Denison's studies of economic growth concerned Europe between 1950 and 1962. Here growth rates have a wide range, some of them much higher than in the United States. European countries were compared directly with the United States. They have a lower national income per person than the United States. Estimates were made of how much of this was due to differences in quality of labor, the amount of capital, results of allocation, economies of scale and several other things. If everything else was the same, output per unit of input in the European countries would still be anywhere from 23% below the United States in France to 34% lower in the United Kingdom.

For Western European countries generally there seems to be a gap in efficiency. It does not seem likely that this can be due literally to lack of knowledge of the procedures, technology and so on, used in the United States. There may be some element of this but it appears to be overwhelmingly in the management and organizational area rather than in technology strictly. Other things enter into it such as legal restrictions, efficient use of resources and, underlining everything, stronger competition in the United States.

In the period from 1955 to 1962, which is the most interesting period because the earlier years are still quite distorted by war time recovery, the residual (interpreted as growth due to advances in knowledge) figure was .75% for the United States. For all of the European countries except France and Italy the range was from .75% to .97%. Most except for Norway were within up to .87%, including Belgium, Denmark, Germany, the Netherlands, Norway and the United Kingdom; the differences are so small no significance could be attached to them. This does not mean that they might not be significant. For Italy, the number was 1.3% and for France 1.56%. In the case of Italy, whether or not the difference is significant was left open. In the case of France, the difference is large enough that it is probably true that France was getting at least some significant amount of growth out of some otherwise unidentified source. It might very well be that France is getting something significant out of transference of technology since they have in fact made the biggest effort toward increasing productivity.

SUMMARY OF REMARKS BY GEORGE WILSON

Dr. Wilson pointed his remarks to the question: growth for what? Rather than growth, he said the burning issue in the United States in the 1950's and the 1960's was a re-allocation. Given what is happening this summer in various cities, it's quite clear that we now need economic growth. And if you include Viet Nam, it becomes even more obvious he said.

Dr. Wilson then turned his attention to the gap between increases in labor and capital and growth in GNP. He said that several years ago, an economist tried to qualify economic growth in the United States historically, and he came up with the belief that you couldn't explain much of the United States economic growth by looking at quantity of labor and capital. This means that whatever it is that increases productivity, arbitrarily defined as output per man hour of input, must be taken into account in explaining growth in GNP. Increases in the quantity of labor and capital explain only about a quarter of the growth of the GNP in the United States over time he said.

He referred to this gap as really a measure of our ignorance with respect to economic growth. Since this was pointed out he said economists have been trying to figure out how to explain it. Can we get a better explanation? Dennison's smaller residual resulted from attempting to break-down the gap he said.

He then referred to the definitional problems relating to how to measure labor and capital appropriately. For example, he pointed out that a ham sandwich becomes a part of a capital stock during its short lifetime. In other words, if you define anything that enhances productivity as something like capital, then the whole distinction between capital, consumption, and investment becomes quite illusiory. He suggested that much of the gap disappears if one is able to correct for improvements in the quality of labor and capital. But he said the way you correct is, as of yet, not a very scientific or unambiguous undertaking.

Next he mentioned innovation. So long as part of economic growth is a function of technology, it has to be used before it'll have any influence on economic growth. He argued that the available technology is of no use unless people adopt it, i.e. innovate. Innovation he said is simply the application of some invention, some known scientific fact, some new product or new process. Innovation is some function of the availability of perceived technology, as well as the incentive to innovate. The availability of technology is partly a function of R & D and other inventive activities. Therefore, innovation depends upon R & D inventive activity, as well as incentive to innovate. This means, he said, that economic growth is a function of all these things, as well as the quantities of labor and capital as inputs; perhaps corrected for quality.

Dr. Wilson reminded the group that we used to be taught that output was a function of land, labor, capital and entrepreneurship; the four factors of production. We only use two of them now. It's very difficult to measure units of entrepreneurship. And we don't use man hours for this kind of computation. He said the question then becomes: what determines the level of "R & D" and other inventive activity; and secondly, incentives to innovate.

Dr. Wilson identified another area of our ignorance as stemming from the fact that we have no idea what levels are optimal, nor whether the kind of proportion; for instance 10% of the total budget is devoted to so-called basic research, is in any sense optimal. He suggested that neither the amount nor its composition; research and development or other inventive activity, bears much relationship to long-run national economic needs. Also the market mechanism will not by itself function adequately in this area he said. As Dr. Colm pointed out, this is due not only to the long although shortening period of gestation, but to extensive externalities, especially from basic research and development. The "spill-over" effects from research are tremendous, and they're hard to capture through the regular market mechanisms he said. Dr. Wilson also emphasized pecularities of the procurement process in advanced technology fields, where the government is the biggest contractor; where the market mechanism itself doesn't seem to function efficiently.

He commented on the literature concerning power, suggesting that the outcome of all this debate is a considerable number of detailed, empirical studies, indicating that there's no relationship whatsoever between degree of monopoly power, or lack of it, and innovation. He said that we tend to forget that in the larger enterprises, the resources of inventive activity are not particularly geared to the large industrial research labs, or even the large enterprises themselves. Most studies suggest that over half of the, "significant inventions" since the turn of the century, are the products of the small, individual firms. He called for an end to this discussion of the relationship of market structure to innovative activity, saying that it's totally inconclusive. Some monopolists are highly inventive and innovative; others are not. Some highly competitive industries are, and some highly competitive industries are not. This forces us into an even more detailed study of the role of technology. Hence he said this question should be left somewhat in abeyance.

In conclusion, he re-emphasized the contention that the GNP gap is really a measure of our areas of ignorance. He suggested that the real reasons for this conference are to figure out: "A" what are we talking about, "B" assuming that technology utilization is as important as we think it is, and as all the empirical studies seem to suggest, how can we stimulate it.

DISCUSSION

DENISON: I would really like to ask George Wilson if you would say anything more about the number of years between a technical discovery and its commercial application.

WILSON: This comes from the Summary Volume, Technology in the American Economy, as reported to the National Commission on Technology, Automation and Economic Progress. I have the statement here. I might just read it: "The typical time between a technical discovery and recognition of its first commercial potential has fallen from about 30 years before the first World War to 16 years between the Wars and 9 years after the second War. The additional time required to convert these basic technical discoveries to initial commercial application has decreased from 7 to about 5 years." You get the conclusion, therefore, that total elapsed time fell from about 37 years in the period 1885 to 1919 to 24 years in the period of 1920 to 1944 to about 14 years in 1945 to 1964.

Now there are two other interesting things that come out of this. The type of market seems to make a considerable difference. If it's a consumer product, the mean elapsed time is 20 years, but for industrial products, 34 years from invention to innovation. The other piece of information is that for government supported R & D inventions there is about one-half the elapsed time between their invention and their successful commercial application as for those that are privately financed. The rationale for that is generally believed to be the patent laws themselves.

One other thing I found most intriguing using an industry by industry approach. If you take the aggregate production function approach you try to qualify as Maurie Brown has done in his book: Theory of Measurement of Technological Change. Then you get what he calls technological epochs. And what he has is decrease in return of scale in his last technological epoch which is 1940 to 1960. I find this somewhat difficult to rationalize in conjunction with a shortened period of gestation. I'm not really sure they're inconsistent but I'm not particularly confident that one supports the other. In fact, it would seem to me that they are inconsistent which really suggests that you have to look at this whole issue of technological change, its measurement, its meaning, etc. in a whole variety of contexts from the firm level to the industry level to the national aggregate level. Then, if you get serious conflict this ought to provide guidelines for further research.

How can we rationalize these diversions and conclusions or are they really diversions? In other words, I see the work that has been done thus far as really preliminary. We used to take technological change almost for granted, aside from an interest in the spirit of enterprise. It seems to me we need much more careful research in how these things in fact do come to the surface. As a background to this, we need the kind of analyses that Ed Denison has done which is quite different from the aggregate production function approach. We also need the aggregate production function approach and perhaps some of the industry studies. Then maybe somebody can put it all together in a new summa technology.

COLM: Since we have an audience of non-economists, largely administrators and so on, we might note that when economists talk to each other, they sometimes create an impression that they really don't know much that is useful. Whenever we touch a technical problem we are so much aware of the deficiencies. I can imagine how some of you must want to tell some of us economists and statisticians "do a little bit more homework before you come to us, and tell us what conclusions to draw."

Perhaps I want to add one more point to the problem brought up by Bob Turner. Some of the most important advances in productivity are not measured statistically. They are quality related.

The first big impact of automation was on inventory control. Statistical evidence suggests that year by year the trend relationship between sales and inventory has declined. I'm not speaking of cyclical factors which complicate the statistical picture. Here is definitely an increase in productivity if you can manage with less inventory. But it is not measured by output divided by man hours because output includes production for inventory. Another example, one particular airline has developed a system for inspection of aircraft without taking them apart. That has permitted them to reduce the reserve units of planes in relation to transportation miles. Again, this means that the same end effect of transporting freight or people can be accomplished with less capital. But since investment in capital is one item in output, it's not reflected in our national productivity. So, concerning the controversy about how net should net be for the purpose of measurement of national productivity, we need these other measurements as well.

The real reaction to all of this is that I do think for policy purposes we know more than it appears from the discussion of technicalities. There is one fact I think stands out: The saying that necessity is the mother of invention should be corrected. It's necessity plus funds. Invention goes where the money is.

I think the first policy conclusion from that is that we should support a high activity economy if we want to make progress on productivity and thereby improve the rate of economic growth. This is a point usually not sufficiently recognized when we talk on the specific problems of innovation or technology utilization. In many of our new frontiers of knowledge, we are dealing with very complex interrelationships. We are dealing with systems and I think in the whole question of urban renewal, transportation and so on, it's impossible to make adequate progress on one element without some measurement of effort in others. For example, I've been told that we are going ahead and building a desalination plant in Los Angeles without full recognition of what the waste byproducts will do to marine resources, to fish life in that area. We need more of a system approach. I'm coming back to pound on the question of problem oriented research rather than discipline oreinted research. We have here people who quite probably want to explore uses of large-scale atomic energy and the area of desalination is the biggest consumer of energy in a concentrated field. But the question of ecology and what the whole thing will do to fish life allegedly is not sufficiently recognized.

I think we know quite a bit about the obstacles to innovation. It is also necessary to make the distinction between innovation and technology transfer. Innovation means the recognition that some invention or some other innovating activity achieves practical application in a firm. Technology transfer refers to what is entirely new for an industry which wasn't used there before. We still have DC3's flying next to the most sophisticated jets. How fast should we go throwing out old techniques? There are economic factors as well. Consider severence pay for displaced workers, depreciation of existing assets, etc. There are lots of economic factors which quite properly slow down the application of new technology. I believe we know quite a bit about these obstacles, even now.

The policy maker in this field really shouldn't have to excuse himself that he can't get proper advice on where the directions of desirable action lie. We don't always know the exact measurements, but we know the directions toward which problem solution should move. Many obstacles of a political nature, of course, are entirely unrelated to these problems.

<u>TURNER</u>: I want to call attention to the fact that one of the major determinants of the economic growth rate which we haven't specifically mentioned is the availability and real cost of natural resources. In projecting the future, this is a thing which has to be taken into account very specifically. This was done a few years ago by Resources For The Future, Inc. They came up with the general conclusion that natural resources would not be an inhibiting factor on economic growth in the U. S. between 1960 and the year 2000. However, they also concluded that for a number of specific resources, there would be severe shortages which would have to be overcome by important technological changes. In particular they had in mind non-ferrous metals where we are going to find very severe scarcities of lead, zinc, tin and copper. They conclude that these shortages can be overcome by applications of technology. We can invent other materials that will perform the same function. Similarly, they found that water in the aggregate would not be a limiting resource on economic growth. However, they also concluded that we are going to have to develop some new techniques for conserving water, for moving it around, for purifying it and otherwise making it useful when we want it and where we want it.

There are two additional points I want to make. First, the costs of first developing the new technologies and of putting them into effect are included in our Gross National Product. This is relevant to the gross versus grossing and netting problem we have been talking about. And, second, simply the fact that if we are to avoid natural resource limitation, we have to make a major effort to develop substitutes and new processes, and this, of course, is of particular relevance to this conference. The technology problem, the problem of technology application and transfer, is particularly relevant to preventing natural resources from being a limiting factor on economic growth.

QUESTION: My management is inclined to equate improved economic status of the employees with economic growth. I would like any member of the panel to comment on the relationship between higher standard of living and economic growth.

WILSON: I'd say they were identical. The increase in monetary income of the workers, in the presence of more things to buy, and a greater variety, is another level of living which is another index of economic growth. The ratio of consumption to GNP may change but by and large the ultimate standard of success is how well we live as consumers.

COLM: I would like to add to George's comment. There is one very interesting example you gave: That the employees not only increase consumption of living essentials but that they take vacations, trips, and so on. Here is a very interesting factor. Increased productivity due to automation would make for, in itself, technological unemployment. But employees are spending more on recreation and labor intensive services. Hence technological advances in the automobile industry, for example, is promoting expansion of the labor intensive industries such as education, recreation, and services.

QUESTION: My question relates to a book recently published by Seymour Melvin of Columbia University, called Our Depleted Society, in which these theses are presented: (1) For various reasons, American Industry, that part of it that is devoted toward the consumer, is running out of innovation, its productive capacity being depleted in all kinds of ways; (2) a great deal of the innovative talent is devoted to space exploration and defense product development. The picture which Melvin paints of the "depleted society" seems to me quite alarming. What I would like to hear is comment on the Melvin theses and the implications for our society of the particular ways in which we are channeling our innovative talent.

TURNER: I haven't read the book, but the first half of the proposition you outlined strikes me as most unlikely. I don't know any criteria by which one would say our consumer goods industires are falling behind; but certainly it doesn't seem to me an indication that productivity is rising less than it has in the past. I don't think that it is true. It might be true if we had more innovative talent going in consumer directions, and lessening the defense effort, we would be still better off; but the absolute statement strikes me as contrary to anything I know.

WILSON: I agree that it would be worthwhile to look into this type of book. But, I think the west Europeans would disagree that this kind of phenomenon is happening in the United States. The question I was going to raise with Ed Denison is now that there is a series of studies trying to measure the comparative technological gap between Western Europe and North America. In fact, Melvin himself did one earlier in which he attributed U. S. technological achievements mainly to aggressive labor unions in the United States and you didn't have this in Western Europe. But there are some studies now worrying about the political and social consequences of this gap that everybody seems to believe will not narrow between Western Europe and the United States. It will get bigger because the best scientists will go where the most interesting R & D is and you get this cumulative affect; even though it may be mis-allocated in terms of some kind of cost benefit criteria.

It seems to me that we are acquiring a lot of this so called brain drain. Western Europe is so concerned about this that they are beginning to put restrictions on U. S. capital flowing abroad. There are certain other objective facts that suggest, however irrational this policy may be from an economic point of view, the technology gap is large and it is probably getting larger. I think what you need to do is get down to almost an industry by industry comparison before you can say much that is positive about it. One result of a recent study is that U. S. competitive success is highest in those corporations which have the greatest amount of research and development as a proportion of their sales. In fact, this study concludes that this finding is consistent with the view that the world economic role of the United States involves a systematic export of new products. The assumption in Western Europe is certainly that they will adopt patterns of consumption much like North America.

It may be that the technology needed 20 years hence already exists; that we will exploit it first because it is mostly developed in the United States; and that sooner or later Western Europe will adopt it. This means that we've got a pretty substantial jump on them and if you keep up this kind of innovative activity by a variety of policies from anti-trust to massive government identification in particular programs and the funding thereof, we may keep on increasing the technology gap.

COMMENT: It doesn't seem to me that the evidence bares out our optimism, after all the brain drain being talked about here is going mostly into the defense and space effort. This is further documented in a recent article in Science by a Laboratory Director of Bell Telephone. Secondly, if one looks at the automobile industry, one is struck by the fact that after 50 years of making products, it still can't make one that is reliable. If I look at what my daughter has in her home today compared with what her grandmother had in her home, I can think of automatic can openers, automatic washing machines and that's about all. Frankly, I don't see where this tremendous advance here is taking place. I would also point out a gross failure to apply technological advances to the area of urban development again with certain exceptions.

TURNER: Now, I'm inclined to agree with the speaker that as a matter of public policy, we have diverted our scientific and technological manpower into areas namely defense and space which to Congress have seemed to be primary. We have slighted civilian technology. Now, this is partly a matter of public policy but it is also partly a matter of a difference in the kinds of industries that are involved. Most of the scientific advances of the past few decades has been in the field of high energy physics, nuclear energy, electronics and the like, and the applicability of this scientific knowledge to many consumer industries, restauranting, leisure time activities, etc. is fairly limited. The places where you can really put that technology to work are defense and space. To argue that somehow we are blundering by not using advanced nuclear physics in running better restaurants doesn't quite make sense.

On the other hand, I think there are plenty of opportunities to utilize some of this technology which we haven't explored. We still carry mail in about the same fashion as we did in 1840 when the Post Office was set up. If we had devoted the kinds of scientific energy to the matter of transmitting written communications that we have to the defense and space programs, we might have completely obsoleted the present postal system. We give some of our scientific energy to the treatment of waste disposal. This is something that is widely recognized, but we still get rid of our sewage the same way the Romans did. If we had put even a small effort into developing a device for getting rid of wastes, we probably would have had one. So, I'm a little bit inclined to agree with the speaker.

COLM: I have full appreciation for this feeling. The question comes up that we are spending billions and billions for space research and the pay off for daily living is very little. When the automobile is mentioned, I always think of plumbing. We are able to do miracles in technology, but I haven't seen any plumbing which requires repair less than once a month. When we talk about technology utilization, we think very often predominately of hardware which has been developed for space and then we find very little use of that for daily living. But we should note that from space technology we have an entirely new concept of reliability control. The transfer of some of the experiences in reliability control to those industries which make goods for daily living could be extremely useful and some policy attention may be given to those areas.

Using this broader idea of transfer, I was most interested in the experiment of California using the system approach to law enforcement and crime control. We should think of utilization of the system approach, of reliability, that sort of thing in which we have made tremendous advances for space work. I can see much more use of these procedural and managerial advances than in the transfer of hardware from one area to another.

COMMENT: I think the panel has pretty much accepted the fact that it does take substantial time to apply technologies coming out of Federal R & D, regardless of whether it is space, defense or health oriented R & D. Then in the next breath, we begin to worry about why we don't see more evidence of it here and now when the real upsurge in Federal R & D spending has been in the last 15 years and the space program just in the last 8 years. Going back to something Prof. Colm mentioned, I think that there is some guidance in all of these statistics for us who might be in administrative roles. I think we could perhaps assume that we are not in a position to change the input side of the innovative activity or change the qualitative mix of R & D spending. If you can't do that, then the question remains what to do to improve the rate of economic growth through technology transfer or through encouragement in tax credits or changing tax systems.

END OF SESSION

LUNCHEON SPEAKER

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TECHNOLOGY TRANSFER AND INDUSTRIAL INNOVATION

By

Sumner Myers

Art Weimer has asked me to talk about "Technology Transfer and Industrial Innovation." I will do this, but in view of our rekindled interest in America's cities I will interlace my remarks with some relevant observations on urban innovation. You'll hear more about this tomorrow from Lyle Fitch.

I have spent a good deal of time studying how technology is transferred among institutions and companies in the private sectors of the economy and I like to think I know a bit about how the innovative process works there. But I feel less confident about how technology is transferred into the public sector, particularly into the urban sector--I say this even though I am now personally involved in the very process of developing technological innovations in urban transportation. This experience has just about convinced me that the industrial model of the innovative process is probably a good approximation of how urban innovation takes place. At least, it's the best I know of. And so, I am going to try to transfer what I know about industrial innovation to a related area--urban innovation.

I am going to draw on four primary sources of information. The first is an NSF study which I directed under Gerhard Colm at the National Planning Association. This study yielded some hard numbers about how technology is used as a basis for industrial innovation. The data I will refer to were generated through an examination of 560 innovations which varied as to scale, creative input, and economic impact. While the data were not intended to represent a scientific sample, I believe they are highly suggestive of the general situation.

The second source is a Conference on Technology Transfer and Innovation which NPA held in Washington a year ago last spring. Since I am using many of the ideas that were brought forth and developed during that conference, I will give credit where credit is due.

The third source is the summer study at Woods Hole on "Science and Urban Development" sponsored jointly by the Department of Housing and Urban Development and the Office of Science and Technology. You may have seen a copy of the report which resulted from that study--"Science and the City."

The fourth is a study that the Institute of Public Administration is working on for HUD. The study is supposed to come up with urban transportation innovations based on evolutionary technology.

In private industry, innovation is more often the result of recognizing and adapting an old idea than of inventing a brand new one. We found this to be true for two-thirds of the 560 innovations we analyzed. It is also likely to be true of urban innovations. For example, already radar has been adapted to traffic control--the motor scooter to police patrol--and the computer to just about everything.

As a matter of definition, by innovation I mean things that are new either to the firm or to the city--not necessarily things that are new to the world. An innovation has been defined as an idea perceived as new by the individual.

It really matters little, as far as human behavior is concerned, whether or not an idea is 'objectively' new as measured by the amount of time elapsed since its first use or discovery. It is the newness of the idea to the individual that determines his reaction to it.

In thinking about innovations, one must consider all kinds of innovations, large and small, creative and less creative. An urban innovation might be as brilliant and revolutionary as Roebling's suspension bridge. Or it might be as mundane and evolutionary as the freeway. Since we are interested in the impact of innovations on urban life, glamour and creativity are not necessarily relevant. It does matter, of course, whether the particular innovation has important socio-economic consequences--like the freeway--or relatively imperceptible consequences--like vandal-proof parking meters. A large number of seemingly "inconsequential" improvements, however, can and do result in aggregate effects of great significance.

In the private sector, for example, a study of DuPont's rayon industry found that the cumulative effect of many small incremental innovations was greater than that of a few large ones. In the defense sector, Ray Isenson of DOD's Project Hindsight, characterizes the weapons systems he studied as the "synergistic consequence" of hundreds of minor innovations. And in the urban sector it is often forgotten that one of the most important innovations in history--the automobile--is the cummulative result of almost a century of incremental innovations. Most people expect future urban innovations to be big ones. I don't think they will be entirely disappointed. But they should expect--indeed demand--lots and lots of little ones too.

Without knowing how the little ones happen, we get a limited and distorted understanding of the whole innovative process. For example, we would fail to understand that contributors to the process or change are not just lone inventors driven by their irrepressible compulsions or images of a pot of gold. There are a multitude of technical people whose daily job is to improve gradually the technology of the firms and institutions they work for. Their attitudes toward innovation are of fundamental importance to the rate and quality of innovations. The sum total of these attitudes determine the propensity of the firm or institution to innovate. I might even say that the sum total of the attitudes of petty bureaucrats towards innovation determines the likelihood that new technology will be transferred to the urban problem.

Harvey Brooks, Dean of Harvard School of Engineering, suggests that transfer occurs along two dimensions--vertical and horizontal. In vertical transfer the general is transformed into the particular; science becomes technology and technology finally becomes hardware. Horizontal transfer occurs when scientific or technical information generated in one context is "borrowed" by another firm, which usually adapts it vertically to meet its own needs. Thus, vertical transfer normally takes place within an institution and horizontal transfer takes place among institutions.

Horizontal transfer occurs at varying levels of generality. Transfers often involve specific hardware or "frozen information." But a good deal of intermediate information is also transferred in the abstract form. It should also be understood that in the horizontal transfer process, one institution's input is another institution's output. For example, in the case of the transistor, the research output of Purdue was horizontally transferred as an input to Bell Labs. Bell, in turn, vertically integrated Purdue's work into its own transistor technology; Bell's research output was then horizontally transferred to other firms, this time in a fairly specific form. Finally, the receiving firms further improved this technology, again vertically. And so we have transistors as we know them today.

Patterns of Horizontal Transfer

To transform scientific or technical information into specific innovations, requires a certain amount of organized effort. In the science-based industries, the extent and complexity of the effort demand fairly elaborate organizational arrangements vertically arrayed within each firm. In the fragmented, non-science based industries, on the other hand, the in-firm effort is relatively simple. The dominant transfer mode here, therefore, is horizontal--from firm to firm--with only a relatively short vertical progression necessary within each firm. I suspect this pattern will hold for urban innovations. My impression is that most of the relevant technology is fairly well developed and can be "borrowed."

"Borrowing" technology depends heavily on informal communication among people rather than on formal arrangements among institutions. Apart from such well-defined units as technical information services and purchasing departments, most companies are not specifically organized to receive new technical information transfers. They may, however, have specific departments responsible for innovating--for example, R & D labs, engineering departments, etc. And because the people in the departments responsible for innovation need new information in order to come up with new products and processes, they are the anxious recipients of technology transfers. Until recently there has been no institutionalized responsibility for urban innovation and, therefore, nobody to borrow technology. I am happy to report that HUD has changed this and we may expect to see some action soon.

In the private sector, borrowing technology from outside the firm provides an important basis of innovation. About half of the 560 innovations NPA studied were based on technical information transferred to the firm from the outside world. Similarly, Jewkes in his well-known study on the sources of inventions, also found that about one-half of the ideas for radical inventions come from outside the company that developed them--for example, Carlson and xerography. Because this pattern of innovation is so strong, I would expect that many radical new ideas for urban innovations will come from outside the community of urban thinkers. In fact, we may expect that many of them will come from people now working in the military/space community.

How does new technical information actually get to its potential user? One thing is certain--not through elaborate computerized information retrieval systems. Most of it comes through personal interactions. Even reading is surprisingly unimportant as compared with face to face conversation. It seems that innovators generally get their information by ear rather than by eye. I will come back to this point later when I describe how the Woods Hole Conference on "Science and the City" worked.

While I am at it, let me reassure those of you who think that lots of highly useful information is not applied to urban problems because we can't get at it. That just isn't so. Our data show that more than two-thirds of the technology transferred into the firms we studied was already widely diffused and generally known to persons in the field. While our numbers also suggest that the big, "million-dollar plus," innovations tended to be based on less widely diffused information, I would say that the problem is not so much access to information as it is the identification of applicable information.

Once technical information has been utilized, its applicability is, of course, quite obvious. The problem is to recognize applicability before information is utilized. For the most part, the problem is a simple one. As noted earlier, most of the information used--two-thirds--was clearly seen as applicable beforehand by the innovator. For example, railroad operators had little trouble recognizing the applicability of the diesel locomotive to their business. And city comptrollers quickly saw how the computer applied to payrolls.

But for a significant amount of information, applicability is not clear to most people in advance, except the innovator himself. We found this to be so in one-third of the innovations studied. In such cases, a creative act--an "invention"--was necessary in order to utilize the seemingly inapplicable research outputs or technical information as a basis for the innovation. Again, this poses a dilemma to those who would step up the rate of urban innovation by simply "pushing" technology. A transfer agent can push what he thinks is clearly applicable information--but how is he to route seemingly inapplicable information to the one man who can inventively use it?

In the private sector, the single most important agent of horizontal transfer is the vendor or potential supplier. And this is likely to be the case in the urban sector too because cities buy so many kinds of equipment. However, the transfer relationship between buyer and seller is strongly affected by their respective propensities to innovate. Aaron Gellman, Vice President for Planning of the North American Car Corporation, refers to this propensity as "I.Q." or Innovation Quotient.

High I.Q. vendors tend to concentrate on selling to firms with "high I.Q." For them selling to conservative, "low I.Q." customers would be too costly and difficult. True, if the high I.Q. seller is powerful enough and the stakes are high enough, the low I.Q. market can be cracked: GM did sell diesels to the railroads and IBM now sells them computers. But, other things being equal, the high I.Q. vendors avoid transferring their outputs to low I.Q. customers. This mismatch of company I.Q.'s represents perhaps the single greatest barrier to transfer and the utilization of technology. I think that you will agree that most of the "customers" for urban innovations--the cities--fall into the low I.Q. category. As I hinted earlier, this is due to anti-innovative attitudes which must be changed if we are to get enough urban innovations to mean anything.

The Active Role of New Technical Information

I will later make the point that if goals for urban innovation are specified and backed with dollars, the necessary technology will be developed to support these goals. I am not alone in holding that the major pattern of innovation is one in which needs, stated as problems, generate technology to get desired innovations. That, carried out methodically, is the systems approach which is now so fashionable. And if only because it is so fashionable, I think it is necessary to emphasize that it is by no means the only way things happen. There is also a minor but fairly significant pattern in which technology itself evokes the need that generates still more technology to get an innovation which might not even have been dreamed of.

Cool logic not withstanding, the role of technology is not always the passive one of being drawn into the solution of carefully defined problems. Granted, good problem statements represent a powerful force in the innovating process. But we must also recognize that new scientific and technical information often stimulates the basic idea for an innovation by defining heretofore undefined needs and problems.

A recent New York Times story makes the point. The story describes an exciting trade exhibit where retail merchants were shown the latest automation techniques for billing customers, controlling inventories and so on. The first line of the story quotes one of the merchants: "All of a sudden you discover that there are problems you didn't know you had." The story goes on to say that "...This comment was typical of the reaction of many other merchants to the presentation of new equipment and services."

We all know from similar personal experiences that new information can evoke a need that seemingly didn't exist before. The question is, how often does this happen? According to NPA data it happened in about one-quarter of the innovations we studied.

And why not? Rossman, a famous writer on invention, observed back in the 1930's that "a problem is best stated in terms of its solution." For example, new information embodied in the "new equipment and services" mentioned in the Times article evoked the statement of a problem that the retailers had not been able to articulate before. The Times story also illustrates another point: before the innovation actually appeared, the market felt little and demanded nothing.

So it is with urban innovations. To paraphrase Prof. Spillhouse, who is one of the moving forces behind the big, new city project in Minnesota, 'urbanities don't know what they want until they see what they might have.' For example, I am told that the NYC Transit Authority once commissioned a study to find out how people felt about the subway. Much to the TA's surprise, they learned that--with the exception of a few egghead types--most people didn't feel anything at all about the subway. It was just a way of life. On the other hand, General Motors generated demand for limited access highways be exhibiting a working model of a freeway system at the 1939 World's Fair.

New technology also lowers barriers to the implementation of old ideas. Ordinarily, few projects that are economically and technically unrealistic are started. Ideas for innovations that are not yet feasible may be shelved. Technology must be used in packages; if all the related pieces are not available, the incomplete package may lie dormant for a decade or longer until some missing piece of technology completes the package.

What are the missing pieces of urban technology? They should be identified and developed in order to give impetus to urban innovation.

This brings me to my final caveat with respect to well-defined technological objectives. A single-minded pursuit of stated urban objectives might foreclose working on "targets of opportunity"--like nylon or Teflon. Such opportunities occur with significant frequency. NPA found that one-eighth of all innovations studied began as work on a different, though often related, problem. Despite the seeming rationality of working in relevant areas towards specific urban goals, a certain amount of "thrashing about" is inevitable. Perhaps it is even desirable. As a university president once put it, "In order to discover anything, you've got to be working on something." Having said this, however, I hasten to add that it is better it be working on something that in itself represents a worthwhile goal.

Goals and Relevant Research

We can assume that relatively few urban innovations are likely to be stimulated into existence by technology alone. For the most part, the innovative process has no self-starter nor does it have a built-in guidance system, nor is it inherently powerful enough to overcome all of the barriers--institutional, financial, labor, entrepreneurial and so on--in its path to success. This is particularly true for urban innovation where barriers are all but insurmountable. For innovation--in either industry or the city--somebody must direct the process toward some objective.

Technology, applied science, and pure science may be viewed as a spectrum of means to achieve man's socio-economic objectives. Of these, technology exists primarily to serve these purposes; its objectives can be set with a fair degree of precision in advance. But how can science, whose outputs are almost by definition unpredictable, be focused on urban purposes?

While the specific outputs of science may be unpredictable, the likelihood of developing a useable result is clearly increased if research is undertaken in broad areas relevant to urban goals. I think we would agree that basic research on the genetic code is relevant to the goal of improved health at least in the distant future. The problem becomes more difficult, however, when the goal has stronger economic implications and the time horizon is shorter. For example, what sort of basic scientific research is relevant to the goal of cheaper housing? While I have yet to hear a good answer to this question, I feel in my bones that it can be answered. Why? Because similar kinds of questions have been successfully answered both in private industry and in the defense establishment. The transistor is an example of how a private firm successfully invested in an area of basic science that it perceived to be economically relevant. You all know the story, of course. The transistor was "invented" at Bell Labs as a result of Shockley's decision in the forties to undertake basic physics research in the semi-conductor field. He was, to be sure, interested in the general behavior of silicon and germanium. But there was another reason for his choosing this area of study. Semi-conductor research was seen as relevant to the techno-economic problems that Bell Labs would encounter over the next twenty years or so. You all know the story so I won't bore you with it again.

The defense establishment has also been reasonably successful in choosing relevant areas of basic research. The findings of a 40-man year study of DOD's research policies points up the significance of "science with a purpose." Basic science was found to have made important contributions to weapons development when the research work was specifically undertaken to illuminate a problem encountered by a weapons development mission. Relevant knowledge produced "to order," so to speak, is more easily transferred to the people who asked for it.

Technological Goals

I have been talking about the need to set urban goals at the science end of the spectrum in order that research outputs may be utilized in meaningful urban innovations. At the technology end of the spectrum, a similar need exists. Fortunately, goals for technology are much easier to set. Most people would agree that in the private sector the goal of technology is to meet needs felt in the market place. Granted, the market place is often somewhere in the innovating picture, but this statement oversimplifies its role, even in the case of private industry.

In the private sector, the market rarely expresses a felt need for a product. Rather, choices are made among alternatives offered by producers, and innovations are either accepted or rejected with a sometimes inscrutable logic. Because the market reacts to innovations critically rather than creatively, the risks of innovating for it are inevitably high. In the public sector, there is, of course, no market place as such. Needs, when they are expressed at all, are expressed through the political process. I'm not sure this makes urban innovation less risky.

Given the inherent risks of innovation, ideas must be carefully examined before they are developed into practical innovations. Here we must understand that abundance--not scarcity--of ideas characterizes technological innovation today. This is certainly true of ideas for industrial innovations. It is also likely to be true of ideas for urban innovations. I wish I had a nickle for every idea around for new transportation or housing systems. The trouble is, many of these ideas are only worth a nickle.

In any event, because there are so many ideas around, those proposed for implementation must be carefully measured against other ideas in a kind of Darwinian process of elimination. Bob Charpie, Director of Technology of the Union Carbide Company, tells us that only one idea is chosen for every 200 that compete for Carbide's technical, managerial and financial resources. Proposed innovations are ranked on a scale according to cost, benefits and risks. Management begins at the top and supports as many (in descending order) as resources permit. A low-placed idea may never get consideration even though in some absolute sense it is a good one. (Someone in the conference audience asked for Union Carbide's surplus ideas.) For both industrial and urban innovations, the objective of the exercise should not be just to avoid bad ideas; it should be to pick out the very best ideas.

And in the final analysis, the choice will be based on a complex of economic, entrepreneurial and political factors.

In the private sector, entrepreneurial skill is the crucial factor in the innovative process. In the public sector, political skill dominates. In both sectors it takes a special kind of ability to look at a proposal and see its market--where it is, how big it is, and most importantly, how accessible it is. Many innovations have met every test, but the last. The market exists, but it cannot be reached. In the case of urban innovation, the need may exist, but political factors may be such that particular innovations cannot serve it. For example, economists generally agree that traffic congestion would be eliminated almost "over night" if autoists were directly charged for using urban roadspace. There are a number of technologically feasible ideas for doing this. But the road pricing approach to eliminating highway congestion is politically out of the question. Therefore, innovations that can do the job have no market--despite the need.

Unfortunately, in the case of both urban and industrial innovations, it is too easy to underestimate what it will cost to translate an idea into reality. One of the key questions is how much time it will take. Time is money; a dollar discounted this year is only pennies when a successful innovation at last begins to pay off.

Given the risks of innovation and the abundance of ideas, Charpie calculates that a company making a ten percent return on normal investments should rule out innovations unless they promise returns of more than 50%. In the case of urban innovations, I suspect that there will be many expensive failures before we learn how to choose the ones that--on analysis--show a big enough margin of anticipated benefit to absorb the costs of unpredictable facts. Most urban innovation proposals that I have seen, particularly in housing systems, projected savings that were too small to warrant the risk of implementing them. The "cover story" for failure is: it would cost less in mass production. Never.

Improperly screened innovations are likely to fail for a variety of reasons. For example, let's take a look at housing innovations again. At least one expert argues that most housing innovations fail because they flout the customer's wishes, or try to solve problems not worth solving. Richard O'Neill, editor of McGraw Hill's "House and Home," asserts that most housing innovations focus on new structural systems for the exterior walls. But he points out these represent only 4% of the total cost of the house and are the most visible part of the house. In housing, technological innovations are accepted only if they do not radically contradict the buyer's image of what a house should look like. According to O'Neill, if this rule is followed and if the idea is good enough, institutional barriers--local laws, union rules, and banking practices can eventually be overcome. But he emphasizes that changes should either be invisible (for example, roof trusses) or imitate an expensive conventional look (pre-finished V-Grooved panelling).

While O'Neill argues that the housing industry has a better record at innovation than most people think, he grants that the industry could use more prophets to stimulate innovation and fewer priests to preserve stability. However, he urges that the prophets should learn the industry's problems well enough to know which are the fruitful areas for innovation. I, for one, feel that this would not dispel the strong feeling of dissatisfaction over the lost potential and the failure of housing technology to meet urban needs.

Science, Technology and Urban Needs

There is a fairly widespread sense of dissatisfaction about the innovative process, a dissatisfaction that is both quantitative and qualitative. Some think it is proceeding too slowly; others, too rapidly. Still others think the output is too wasteful, or too irrelevant to society's needs. There is a growing impatience with the lag between discovery and application; and, at the same time, dissatisfaction that technology is failing to solve society's most pressing problems--especially urban problems.

Most of the dissatisfaction seems to arise from a feeling that is often expressed in statements like: "if technology can get us to the moon, it can get us home from work faster, safer, and cheaper." Spectacular innovations in weapons and space have convinced many people that the output of the research and development establishment offers unique opportunities to meet urban goals. Presumably there remains only the problem of deciding what the urban goals are and who will pay for achieving them. In a pluralistic society this is easy at the general or "motherhood" level, but it is extremely difficult to do this at the urban level--where it counts.

It has been suggested that urban goals will take care of themselves--that the more important goal is to help business innovate, because more industrial innovations create the wealth which makes urban betterment thinkable. This is a variant of the somewhat discredited "what's good for GM" theme. But, in a curious way, it is relevant to the problem of urban innovation. Therefore, I will address myself to it.

Perhaps the best way to help business innovate is to stimulate the economy as a whole. A rapidly growing economy obviously expands the market for innovations and encourages investment in new ideas. And this helps pave the way for urban innovations. How? By making people more receptive to innovation, including urban innovation.

As one observer put it: "The chief factor making for innovation in a community is prior innovation." This deceptively simple truth has also been noted by Barnett:

> "Innovation flourishes in an atmosphere of anticipation of it. If the member of a society expects something new it is more likely to appear than if it is unforeseen and unheralded. The chance frequency will be augmented in proportion to the number of expectant individuals. It is like seeing ghosts at midnight. The greater the number of people who expect to see them, the more frequently they will be seen. In some societies there is a tradition of expecting change. The anticipation is a conscious belief that change is going to take place."

If I may disgress for a moment, Professor Wilson made the point that innovation depends on incentive and incentive arises from cultural bases. I would assert that the space program particularly contributes to the culture of innovation which itself stimulates innovation.

The word "innovation" itself has already become a cliche. Employment ads in the New York Times promise "Challenge" and "Creativity" in larger and larger type, week after week. The once stodgy U. S. Steel hammers away on TV about "Innovation" as if repitition will validate the image. It would be easy to dismiss all this as superficial. Yet the emergence of innovation as a cliche is but a recent phenomenon. Its recognition as an ideal--however imperfectly attained--is but the conventional wisdom describing profound changes in our society. I almost wonder if these very changes have not brought us together to talk about urban innovation.

Stimulating the economy will undoubtedly yield more innovations and hopefully will prepare the ground for urban innovations to come. But private-industry innovations themselves will be "more of the same" and therefore, will still fail to satisfy public needs. This should not be taken as a criticism of innovation in the private sector. Generally, the products of American industry are more than satisfactory for private purposes. The unsatisfactory ones are usually eliminated in the market place. Yet, something is missing. There are few industrial innovations developed specifically to fit into urban systems. For example, component innovations in housing determine the system rather than the other way around. So housing costs more than it should and is not as good as it might be.

Private businesses acting alone cannot ordinarily reverse the process. Business executives, as public-spirited citizens, may be concerned about institutional barriers that preclude socially important systems innovations--urban or otherwise. However, as businessmen, they can't do much about it. They are responsible for outputs of their businesses and they must ordinarily work within the narrow confines of their company responsibilities to maximize profits and minimize risks for the firm. Thus, a railroad executive worries about running his railroad, an automobile executive about manufacturing cars. Individually, neither of them can do much about optimizing the system for moving people and goods in an urban area.

The difficulty is compounded when those who now perform essential parts of a function refuse to modify their operations to meet the needs of the whole system. These vested interests constitute by far the most serious institutional barriers to socially important innovations. Ordinarily they can't be ordered to collaborate. Nor will they do so unless they clearly see something in it for them. The problem is how to provide the means for inducing such firms to integrate voluntarily into a system that performs a socially desirable function.

Money is the force that can align private interests with public purposes. By coupling systems requirements to dollar incentives, it will be possible to generate the outputs called for by subsystems innovations.

John Rubel, former Assistant Secretary of Defense for Engineering, suggests that this lesson is the most important transfer from the military/space effort to the urban problem. In arguing for building brand new technologically advanced cities from scratch he said:

"--- one thing we had discovered was that when you create a market for rockets to the moon, you get rockets to the moon. There is no market that is not served by some industry or business, and no industry or business that is not served by some market. We'd learned that if you don't have the technology for something, you can create a market and get the technology. The method of creating a market for a solution to a problem has proved itself capable of producing the technology to solve the problem."

While this overstates the case somewhat, as I have indicated earlier, the approach is essentially correct. Can this approach, transferred from the military/space experience, be applied to less grandiose situations than building whole new cities? The California School construction project is evidence that it can.

A group of your architects at Stanford University created a powerful market for innovative school construction systems by aggregating existing but heretofore fragmented markets. Thirteen separate school districts in California together needed 22 new schools. In a project sponsored by the Ford Foundation the group of architects helped the 13 districts to identify their needs and translated these needs into performance specifications. Manufacturers were then asked to propose and bid on subsystems that would meet the performance requirements.

Because products as such were not specified, component suppliers were free to come up with new innovations. And because the market opportunity was a fairly substantial one, they found it worthwhile to do so. Indeed, to meet performance requirements of the various subsystems, component suppliers spent over $2 million of their own money on R & D. What's more, much of their research output was later utilized in other construction systems.

Having told you of an approach that has already succeeded, let me tell you of one that I think (or at least hope) will succeed--the story of the Woods Hole Summer Study on "Science and the City." I will concentrate on the part I know firsthand--through serving as Executive Secretary of the Transportation Study Panel.

Last June, HUD, adopting a technique found useful by DOD and NASA, convened a multi-disciplinary group of specialists for three weeks to come up with innovative approaches to various aspects of the urban problems. The group was split into five panels--New Housing, Rehabilitation, Environmental Engineering, Health Services and Transportation.

The transportation panel was made up of "systems" engineers from the military/space program and the universities, transportation specialists, urban sociologists and political scientists. I would divide them broadly into two categories: the "soft" scientists, who were sure they knew what the urban transportation problem was and the "hard" scientists who were sure they knew what the technological solutions were.

After two weeks of interaction, the soft scientists had a different concept of the transportation problem and the hard scientists had abandoned their earlier solutions for more promising ones. Specifically, when we started, the "soft" scientists felt that the problem was how to induce auto users to switch to mass transit and the hard scientists had all kinds of ideas for super-fast rail-like vehicles that would attract motorists. By the time we finished, the problem was defined as improving the public transportation system primarily for the benefit of the disadvantaged who for one reason or another couldn't drive. And the solutions were almost all related to road transit rather than rail. If you've read the report on Woods Hole, you might have wondered why "Science and the City" doesn't present rail innovations as a panacea. In this respect the reports are absolutely unique.

I attribute our complete reorientation to the fact that the two groups had enough time to iterate between problems and solutions. It was not a one shot Brain Storming session. The dialogue kept on until we reached a consensus about what the urban transportation problem was and how to solve it. I should emphasize that this consensus did not come about because it was required. Our different conceptions of the problem and its solution began to merge as each of us transferred his specialized information to the others.

As I hinted at the outset--I don't know whether the Woods Hole approach to urban innovation will result in new transportation systems that will actually perform as we expect them to. We are now hard at work developing most of the concepts that were finally recommended by the transportation study panel. If five years from now I can actually push a button and summon a taxi-bus to my door, I will recall that this urban innovation resulted from the technology transfer that took place at Woods Hole. I will also emphasize that the transfers occurred because we had enough time to decide precisely what problem we wanted to solve. And as someone put it in one of the numerous papers, problems are solutions in disguise.

SESSION NO. 2

THE ROLE OF THE BUSINESS SCHOOL

Chairman:
W. G. Pinnell
Dean of the Graduate School of Business
Indiana University

Moderator:
Paul W. Grambsch
Dean of the School of Business
University of Minnesota

Panelists:
Donald J. Hart
Dean, College of Business Administration
University of Florida
President, American Association of Collegiate Schools of Business

George Kozmetsky
Dean, College of Business Administration
University of Texas

Daniel Teichrow
Head, Division of Organizational Sciences
Case Institute of Technology

Willis J. Winn
Dean, Wharton School of Finance and Commerce
University of Pennsylvania

INTRODUCTION

Dean Pinnell welcomed the conferees to the new School of Business building and then introduced Dean Grambsch.

To set the theme for the session, Dean Grambsch commented on the origin of schools of business and their contribution to education. He emphasized business education as an exportable type of education making significant contributions in a "world wide" sense. He commented on the radical changes taking place in business education including subject matter, curriculum, academic attitude and recognition of obligation.

Names such as Schools of Management, Industrial Administration Business and Public Administration were criticized as too narrow. "I want to stress the fact that we are dealing more with the general topic of management and of the problems of organized society today and not strictly business in the narrow sense of the manufacturing firm. In some of our schools we now find programs that are dealing with recreation, international affairs, technological change, innovation, research administration and things of this kind that are really going beyond what had been the old traditional molds of accounting, finance, marketing and so on."

SUMMARY OF REMARKS BY DANIEL TEICHROW

Dr. Teichrow's remarks were focused on research in the business schools, on what research contributions have been, and what might be done better in the future. He particularly emphasized the area of formalization of business problems in terms of the mathematical sciences including computer science. In other words, the areas that are covered by the terms Management Science, Operations Research, and Information Processing.

Referring to the Library of Congress report, Policy Planning for Technology Transfer, which defines technology transfer as "the process of matching solutions in the form of existing science and engineering knowledge to problems in commerce or public programs," he enlarged the definition to include management technology.

Having established the need for these new technologies in the industrial communities he pointed out that the required technologies are being developed. The methodologies such as linear programming, PERT cost, program budgeting, cost effectiveness, and large scale information systems have benefited tremendously from the federal effort that has gone into developing military systems. He mentioned the professional societies that have grown up in the last few years, the Operations Research Society of America, the Association for Computing Machinery, and the Institute of Management Sciences. It was also emphasized that the problems of technology transfer exist just as much for the developments that are developed in universities and in firms themselves as for those that are developed in the government.

Commenting on the effective utilization of the developing technologies, Dr. Teichrow suggested that not all technologies are worthwhile, and any firm that rushes in and adopts something new just because it is new, is likely to find itself in trouble. The validation and evaluation of the new methodologies must wait for firms that are in an appropriate position for experimentation. But, he said, even making these allowances, newer technologies could be adopted a little faster than they have been.

He then focused his remarks on the effectiveness of dissemination techniques employed pointing out that except for government secrecy, incentives are all in favor of rapid and wide publication of research results whether they be positive or negative. But in areas related to management, exactly the opposite is true. Firms, either consciously or subconsciously, tend to discourage publication, because of the time required to prepare papers for publication or because publication might result in a loss of competitive advantage. Another problem emphasized was the limited availability of some reports.

Concerning the role of the business school Dr. Teichrow stated that the business school has to play an intermediary role between developers of new management technology and those who will implement the techniques, or who will assist in their implementation. Incorporating new methodology into curricula is a very slow process he said. The business schools must emphasize developmental or applied research, the kind of research that deals with how the methodologies, which are already described in the literature can be applied to real problems. He indicated that unfortunately, this kind of research is very difficult to finance, and the most promising answer to this is projects which receive support from a number of firms that are closely related to a basic problem.

He concluded that the business schools have a central role in technology transfer. This role will require considerably more applied research than has previously been conducted in business schools, and this in turn will require relatively large amounts of research funds.

SUMMARY OF REMARKS BY DONALD J. HART

Dr. Hart's remarks were directed primarily to the role of the business school in promoting technology utilization and economic development by dissemination through the educational process. He proposed an even broader definition of technology than Dr. Teichrow, that is: the practical arts of getting something done. He posed the question: Is disseminating technological information by business schools a function which might accentuate obsolescence, both in industry and education--obsolescence rather than progress?

In commenting on the time lag problem Dr. Hart pointed out that there is a substantial time lag before universities acquire technological information, in order to transfer it to other possible users. Given the current and anticipated future rate of change, the rate of obsolescence of some technological developments may be faster than the rate of dissemination through universities. He stated that trade and professional associations serve as effective and timely transfer agents and that a faculty can atrophy rather quickly if its primary function becomes that of a funnel or a pipeline or a distribution system. Consequently the business school has an important role in creating new technology and in developing creativity in other people, whether it be students or businessmen.

He emphasized the need to create a climate for creativity. The expansion of personal knowledge within an individual through appropriate educational processes, plus related recognition of the parameters of specific problems, plus development of acquired analytical skills, represent an intellectual environment in which innovation, whether creative or adaptive, is more likely to occur. Limitations were identified as physical, financial, time, competition, behavior, law, culture and social as well as the limitations of the state of the various arts involved. He stated that technological innovations can neither be developed nor adapted without the ability to analyze and solve problems within the contexts of relevant limitations. This means that the innovator or adaptor must first recognize the constraints. Therefore, the primary role of business schools is one of developing the capacity to solve problems which are complex, inter-related, and often much broader than implied by the older traditional functional study of business.

Having established that business schools have a far more central educational role than merely disseminating technological information, he discussed the necessity of the dissemination function pointing out that the function must be performed for businessmen and practicing managers as well as students.

SUMMARY OF REMARKS BY GEORGE KOZMETSKY

Dr. Kozmetsky discussed the role of the business school as a catalytic agent to facilitate the innovative process. He set forth three assumptions. First, that the sixteen or seventeen year lag between conception and innovation can be shortened through the telescoping process. Move development back into research and move production back into development, and you do come out in a shorter time. Secondly, one does not have to be a scientist or engineer to manage research at an executive level. Thirdly, the whole shape of the affluent society in the highly industrialized culture that we live in is changing the concept of management. Within this assumption framework, then he identified the role of the business school as one of providing leadership to the business community as well as government.

He emphasized the need for the multi-disciplinarian or inter-disciplinarian as the emergent manager. Business schools have promoted this through adoption of the integrated approach to the solution of business problems. He further emphasized the need for "business laboratories" wherein the tools resulting from the integrated approaches can be validated. Much of Dr. Kozmetsky's remarks centered on this need for validation. He illustrated this with many problems ranging from linear programming to industrial marketing. He advised that business firms, along with other agencies need to sponsor much more management research. He suggested new areas of research in which business schools should pioneer include Research and Development management, population problems (school drop-outs and flunk-outs are the majority of the voting public), effective Medicare and improved management of preventive medicine, more effective geographical area development and utilization, information transfer and better exploitation of our total national resources.

SUMMARY OF REMARKS BY WILLIS J. WINN

Dr. Winn's remarks were directed toward the business schools role in public policy as related to technology utilization and economic development. He cautioned that in fulfilling the role of constructive criticism they should be ever aware of their image as "institutions run by amateurs to turn out professionals." He lauded the breaking down of traditional functionalism in schools of business and the emergence of the integrated approach. He was particularly concerned about the effect of this movement on the existing upper levels of management and their susceptibility to obsolescence. Further, he felt the utilization of more and more leisure time may influence policy questions.

Dr. Winn re-emphasized the need for better management of our total national resources as discussed by Dr. Kozmetsky. He questioned the continued use of traditional techniques in the education process. Specifically in the policy area he suggested the use of much more experimentation and/or simulation before implementation. Negative income tax was cited as a good candidate for this type of approach. Conflict at the family, local, state, national and international level was suggested as an expensive but potentially fruitful area for experimentation to determine the probable fiscal, social, and political implications of proposed policies.

Finally he commented on the international interchange of knowledge, multi-directional transfer. It was suggested that in some instances we may be distributing our ignorance rather than our knowledge.

In all the above activities he suggested a prime role of the schools of business as being that of constructive critic.

DISCUSSION

QUESTION: Business schools are a little bit "out-in-the-cold" relative to attracting resources to the environment which they occupy. The scientists and the engineers are able to attract federal funds. The medical sciences have the National Institute of Health. Do you have some comments on how the business schools are going to attract the necessary resources to go in the direction that you indicate they must go now?

WINN: I think the real resource is the talent, with respect to the faculty capacity. And if you are able to secure this, the other resources will be made available. For instance in the health field the support is readily available if you can come up with ideas and developments in this field. If you can challenge industry, government, foundations and others; if you have something to contribute, or if your efforts have a pay-off in the profit sense, I have confidence that the resources will be made available to keep everybody occupied that's talented in the area concerned.

KOZMETSKY: Resources are always difficult to get, even under the best circumstances. We've found that the business community will give you "seed" money, if you can show them that in time, like one year, they're going to get some pay-offs. The government, on the classes of problems I've discussed with you, is forcing everyone to go into inter-disciplinary research and it has some benefits as well as some problems.

GRAMBSCH: It is true that we haven't had the money resources, but this isn't at the heart of the problem. As Dean Winn has pointed out, it's the faculty resources that are short. We have not had a research tradition in business schools. To draw the paralell to the equity capital problem there isn't anywhere near the shortage of capital that there is of good commercial ideas.

QUESTION: Dr. Kozmetsky, how many ex-government, ex-industry executives do you have on your faculty? How many people from disciplines that are not normally construed as business disciplines are on your business school faculty?

KOZMETSKY: At Teledyne I was able to succeed with three. Currently at Texas I have engaged three--this exhausted the funds available. One of them got his Ph.D in medicine. He then worked for seven years in aerospace research for the Air Force, headed life-sciences for Douglas Missiles, established research policies for NASA for three years in Washington; and spent four years on the Presidential Space Council. One has spent the last nine years at Stanford studying how to manage technology in general and in particular the problem of building hypotheses. The third is an Electrical Engineer who has worked on guidance systems at MIT and who was acting head for the computer lab for NASA.

QUESTION: The value of specialization in the disciplines has been our ability to look for truth; to push back the frontiers of knowledge and see relationships. Isn't there a danger, that in our preoccupation with the techniques, which is now being posed in the business schools, we will ignore the search for truth?

KOZMETSKY: I agree whole-heartedly. You have to go for truth.

QUESTION: Could you elaborate?

KOZMETSKY: We have no techniques to work on those problems that I mentioned. For example, I can't turn to the management scientist and tell him, "Give me the technique to manage a forty division company with each division having entirely different product lines and different technologies." It is not available until we research the problem and validate the findings.

COMMENT: The implication is that the traditional disciplines such as Economics, Sociology, and Social Sciences, have nothing to offer us in management.

KOZMETSKY: No. That's over-simplified. For example, economics is extremely valuable, and for me Galbraith's book is very exciting. If you listened to some of the speeches we had this morning, and you go through Galbraith's book with that point of view in mind, therein lays a framework. A conceptual model is what we're good at in social sciences. But we're not as good at the relevant details as is the physical scientist.

COMMENT: My argument is that we're stressing methods rather than content, and I wonder if this is good.

GRAMBSCH: All schools are trying to build in more of the fundamental disciplines. Right up through to the Ph.D now there's a lot more emphasis on fundamental discipline than there was a while back. I think what we're really getting at is how to make these disciplines useful in the solution of these problems. In one way the business schools might not ever have come to pass, if these relevant disciplines had concentrated on their applications to management problems.

QUESTION: Perhaps the basic question being raised here is: isn't the business school aiming toward the 'non-disciplines'?"

GRAMBSCH: Or toward a new discipline, if you will.

TEICHROW: I think part of the problem is, of course, what is a discipline? And what used to be economics is not what economists are doing today. The same thing applies to sociology, and the other so-called disciplines. I think new truths are being discovered, but they don't fit nicely into the old framework. They cut across.

GRAMBSCH: This is especially true in economics and political science, where a great deal is happening.

TEICHROW: It's happening in the physical and life sciences as well.

QUESTION: Dean Kozmetsky, you mentioned that one of the things you learned is that you don't have to be a scientist or engineer to manage R & D. How close to the bench level is this true? In your experience.

KOZMETSKY: I went right down to the bench.

COMMENT: I thought you did, and I couldn't quite follow that.

KOZMETSKY: All I mentioned there is the fact I have never had any formal training as an engineer or a scientist, physical scientist. For example, all my work today is in bio-chemistry and bio-physics. That's what I spend my time learning. What I do, obviously, is not only read the literature, but I follow, like you all do, all the leading people in the field. You get to know them, and you discuss problem areas with them. Then you get some feelings and understandings.

Yes, I know how to solder and I know what the diffusion processes are. I know how it gets involved in the mechanical end. I have been up nights and cleaned rooms getting dust out of discs and air-bearings, and all that sort of stuff. You have to do that. You must get to that understanding. It's obvious what that'll lead to: some place in the future, we need to get that into our classrooms.

QUESTION: I'd like to ask how you build into the reward structure of business schools, incentives to get people to do the kinds of things you are talking about? It seems to me, most of the newly graduated students, whether they are Ph.D's in economics, or in engineering, or in medicine are oriented toward doing research, the type that is very difficult to apply in order to be recognized by the academic and professional rewards among the various societies.

KOZMETSKY: As a Dean, I have to construct an environment for this. I am also Associate Chancellor for the University of Texas, reporting directly to the Board of Regents. So, I made sure I had the environment. Secondly, you very patiently bring in cross-disciplinarians, who feel very strongly that they want to transmit knowledge. You attract these people for younger people to work with. You go out and raise the money and provide the ability to go ahead and do the work. Then there's nothing like the success that comes from the research project that they do. Then you hope that you may have spoiled them for life, and the real world.

QUESTION: Professor Kozmetsky, I was just wondering, when people get out of school, whether it is a two year, four, eight or ten year situation; usually they are a little sick of school. Now how do you get them actually to go willfully into at least your two year training program, if not to go further then?

KOZMETSKY: I'm toying with that problem. All year long I've had members of my faculty working under the constraint that they're to come to no conclusions until they feel they have reached the right solution on that problem. So far, they're toying on it, so let me just express my own personal opinion. Given the present environment in the universities, teaching in continuing education is low on the social status. As long as that continues, I don't think that the colleges are the proper place to do this; therefore, I think it's a very profitable type of business. And my economic analysis of continuing education suggests you can make five times the profit from it that you do in selling a best-seller textbook. I think if we can get that started, it would help break the problem. Perhaps it should be that way. After all, it isn't scholarly, it isn't research, it's money-making.

QUESTION: I'd like to address this to all the panelists; the subject of international trade. How do you handle this subject in your business schools?

HART: One of the problems here is that if you get into the mechanics of international trade you're dead, from the point of view of the values of the student. Here again, you get into some obsolescence factors. You get into changing competitive situations, country versus country. More importantly, if we try to relate foreign trade as a tool to help develop some of the so-called under-developed countries, and use as bench-marks to implement foreign trade policy, as well as forms of governmental assistance to other governments, we get boxed in by making assumptions as to motivations of people in other countries being the same as the motivations of people here. This is not necessarily so.

I think we're going to have to engage far more in understanding economic systems. Not in the sense of capitalism, communism, fascism, but in terms of real systems analysis of a kind in which we have never engaged. The parameters include economic systems, kinds of market structure, kinds of motivation, kinds of tradition, kinds of cultural and social environment, kinds of political structures and histories. Consequently we're trying to imbue students and business people with the idea that they're going to have to take a different kind of a look at foreign markets than they do at domestic markets before they can analyze what their opportunities are. A lot of firms have learned this the hard way and have actually gotten "burned out" had their foreign properties confiscated or nationalized, because they failed to recognize that the problems are different in this environment than they are in our own. Now, that's not a direct answer, because I don't think the answer has been firmly formulated.

END OF SESSION

DINNER

Chairman:
The Honorable Robert L. Rock
Lieutenant Governor of Indiana

Speaker:
The Honorable J. Edward Roush
Congressman, 5th District, Indiana

SUMMARY OF REMARKS BY LT. GOVERNOR ROCK

Mr. Rock welcomed the conferees to Indiana. He commented on the role of the Indiana Department of Commerce which he heads plays in promoting the economic development of the State. He then introduced Congressman Roush.

SCIENCE TO SALES

By

J. Edward Roush

I would like to begin my comments tonight with a quotation. It reads:

> It is an extraordinary era in which we live. It is altogether new. The world has seen nothing like it before. I will not pretend, no one can pretend, to discern the end; but everybody knows that the age is remarkable for scientific research into the heavens, the earth, what is beneath the earth; and perhaps more remarkable still is the application of this scientific research to the pursuit of life. The ancients saw nothing like it. The moderns have seen nothing like it until the present generation... The progress of the age has almost out-stripped human belief.[1]

This passage was not written yesterday, or ten or twenty years ago, but one hundred and twenty years ago by Daniel Webster for the opening of a new stretch of railroad track in New Hampshire--a new kind of technology then. The year was 1847. In the history of science and technology that is eons ago.

It takes little thought to reconstruct the influence that bit of technology on rails had upon nineteenth-century America. The railroad was both cause and effect of the rise of big business, the industrial boom of the late nineteenth-century; the migration of immigrants from Europe to America and thence to the great Northwest; the beginnings of urban America, the vast extension of available farm land. And many feel that it was the railroad that tied together Northern productiveness with the military machine that saved the Union during the Civil War.

Nor can we stop there, for, like the industrial revolution two centuries before, the economic, social and even political effects of this single piece of technology were and <u>are</u> manifold. Congressman Emilio Q. Daddario, Chairman of the Subcommittee on Science, Research, and Development of the Science and Astronautics Committee (on which subcommittee I serve) has proposed the establishment of a Technology Assessment Board for he is convinced that: "...technology costs a lot of money, brings up perplexing problems of hazard and benefit, and beckons to an evermore complex future."[2] His statement was intended as a prefatory remark to a

Report of his Subcommittee, just published this summer, which summarizes scientific affairs in and during the 89th Congress. This Report, which I would recommend highly, explains, in the words of Chairman Daddario "how strongly science and technology is being /sic/ latticed into the structure of government and into the patterns of every day American life."[3]

It is this weaving of science and technology into all aspects of American life which must be of interest to legislators in Congress, particularly those, like myself, assigned to the Science and Astronautics Committee. I am impressed by and convinced of the importance of applying the fruits of scientific knowledge to the many needs of man. As President Johnson has commented on this matter "... the test of our generation will not be the accumulation of knowledge... our test will be how well we apply that knowledge for the betterment of mankind."[4]

I shall largely confine my remarks tonight to the role of the federal government in bringing about technology transfer, the utilization of the results of research and development activities, the public consumption, so to speak, of technology developed by the government.

In studies done for the President's Commission on Technology, Automation and Economic Progress last year the discovery was made that the typical time between a technical discovery and recognition of its commercial potential has fallen from about 30 years before World War I to something like 9 years since World War II.[5] This is a significant move toward applying new knowledge for the uses of the American people.

Such technology utilization is undoubtedly the joint responsibility of industry, private research facilities (including universities) and government--all represented here tonight--since both economic progress and human welfare rest on the effective transfer of information acquired in one sector to the needs and potentialities of others.

The rationale for government interest and expenditures is clear and simple. It is the expected return on the investment made: the return in increased industrial growth, new businesses and high employment, educational, health, social and other benefits.

Another factor to consider is this. Given the nature of the information discovered by means of federal R&D efforts, it is difficult if not impossible for any interested organization to presuppose, foresee the technological implications unless the government chooses to disclose these.

What, then, is the role of the federal government in effecting the wide-spread return on its expenditures for R&D?

The part the federal government can play in fostering the transfer of federally controlled technology ranges from mere publication of availability to active development assistance for new civilian applications. This is horizontal technology utilization, the transfer of information from one agency, one field of science or industrial sector to another--across industrial, disciplinary and regional boundaries.

Existing federal policies regarding technology transfer vary among agencies. With some government-sponsored R&D the transfer mechanism is built in. This would include much research for the Department of Agriculture or the National Institutes of Health.

The real problem or potentiality arises when a technological innovation made within the government is not obviously applicable elsewhere in non-government enterprises. How is this information to be communicated, at whose cost, what control can be expected, how much can the private sector be expected to sponsor, how much the federal government since the total economic health of the nation is improved thereby? These rapid fire questions are all innate in the problem. I do not know all the answers. I can report on some of the load of responsibility that has been assumed by the federal government.

The Department of Defense has seen no necessity for special dissemination and application efforts because its patent policy is supposed to provide the incentive for private transfer programs. However, the security and administrative restrictions on DOD reports keep about 1/3 of all federally controlled technology out of the conventional information retrieval system.[6]

Overt, special transfer programs are underway by the AEC and NASA. I am most familiar with the latter as a result of my membership on the Science and Astronautics Committee.

NASA has employed technology utilization offices in its various installations to seek out important research and development results. It has also placed legal responsibility on its contractors to report the new technology resulting from work done under NASA support.

In April Dr. Richard L. Lesher, Assistant Administrator for Technology Utilization at NASA, reported to the Science and Astronautics Committee on this very facet of NASA's activities. I shall summarize elements of his report.

The most familiar announcement medium is the <u>NASA Tech Brief</u>. By April of this year, 1,313 of these had been issued and they expected to issue nearly 1,000 during this calendar year.

Innovations of special significance or extreme complexity are announced to business and industry in <u>Technology Utilization Reports</u>.

<u>Technology Surveys</u> are another means of disseminating this information. Where NASA has made major contributions to the state-of-an-art, an authority in that field is retained under contract to document and interpret the advances for the use of those outside aerospace. As of April, 12 technology surveys had been published and 21 were in preperation.

NASA also conducts conference on new technology for the non-aerospace community. At these conferences NASA experts report and the proceedings are also published.

During calendar year 1966 NASA answered more than 8,000 inquiries for additional information about new technology emanating from aerospace projects. More than 54,000 Technology Utilization publications were purchased by industry up to January 1, 1967.

Considerable progress at the experimental Regional Dissemination Centers is taking place. Two hundred and forty three companies are paying annual membership fees for services to these centers which are thereby expected to become self-supporting. By the end of calendar 1967, I was proud to hear, Dr. Lesher told us they expect the Aerospace Research Applications Center here at Indiana University to be self-sustaining.

Although decentralization of federal efforts at technology reporting still seems to prevail, cooperation among agencies is not thereby outlawed. During this last year NASA undertook a joint program with the AEC in which that agency appointed Technology Utilization Officers at its laboratories who operate in the same manner as the Technology Utilization Officers at NASA field installations. The new technology they identify is evaluated and announced to industry through the NASA Technology Utilization Program.[7]

Yet much remains to be done. A report of the Subcommittee on Science and Technology to the Select Committee on Small Business of the United States Senate, entitled "Policy Planning for Technology Transfer" was prepared this spring. In analyzing the progress from "Science to Sales" they reached a number of interesting conclusions, attached hereto as an appendix. Many of the points contained therein are discussed in these comments.

One of the conclusions is that the State Technical Services Act of 1965 has established a responsibility for aid to industry in applying technology. Parenthetically I might mention that this act embodies the conviction of some that technology transfer must be kept decentralized. The Office of State Technical Services concentrates on identifying user needs and has served an important function, cooperating with the federal agencies which develop the new technology, new information that will meet these needs.

The Report to the Select Committee on Small Business indicates that the results of this jointly funded Federal-State program indicates that business management in many regions is still unaware of the opportunities in applied research and technology; moreover, that fundamental education and counseling may be necessary before a demand for technology is generated in local industry.[8]

That same very thorough and interesting report notes that federally generated technology may well produce in the future: the stimulation of basic science via the feedback from applications of new technology; new processes and techniques; new products and devices to replace former methods and provide capabilities not previously available; cost reductions in goods, processing and services; increased availability (and lowered cost) of radical or exotic instruments, equipment, and materials; direct transfers of packaged technology; or applications for other industries.[9]

I can put some flesh on the bare bones of these comments and prognostications right now. On May 28 Parade Magazine called attention to some of the "fabulous developments that have come to everyday life from space research." Some of these and their applications to human welfare are as follows:

--a TV camera so tiny it can be dropped down your throat to study ulcers or possible ulcers;
--an ultra-sensitive device to detect the now undetectable first faint muscle quivers of dread Parkinson's disease;
--a heart examination table that escapes all foreign vibrations by suspending the patient on a sheet of air;
--a versatile electronic system that can keep close watch on 128 intensive-care patients at one time and "shout" an alarm if one needs instant attention;
--"magic glasses" (ready commercially in a year) which allow a person paralyzed from head to toe to control the lights, feed themselves, turn on TV--by a simple movement of the eyes;
--a novel educational device permits students at a glance to determine the relative positions of the planets on any given day between the years 1900-2000.

And these are but a few of the advantages that may accrue to human life from seemingly unrelated federally supported research and development activities.

In conclusion I should like to quote a statement of Dr. Richard Rosenbloom in his report to the National Planning Association on this matter of technology transfer:

> Technical information has become one of the most important factors of production--next to the classical factors of land, labor, capital and management. This factor must be the concern of a government charged by law with the promotion of conditions favorable to economic growth and the creation of employment opportunities.[10]

I agree. For this technology utilization is not only important in extending our knowledge, but in improving the quality of life of the American people. That is, after all, what a Congressman must worry about.

FOOTNOTES

1. Quoted in John Diebold, "The New World Coming," Saturday Review, July 23, 1966, p. 17.

2. Technology Assessment, Statement of Emilio Q. Daddario, Chairman Subcommittee on Science, Research, and Development of the Committee on Science and Astronautics, July 3, 1967, p. 5.

3. Science, Technology, and Public Policy During the Eighty-Ninth Congress, Report of the Subcommittee on Science, Research, and Development of the Committee on Science and Astronautics, U. S. House of Representatives, June, 1967, III.

4. President Johnson, On Signing the State Technical Services Act, Public Law 89-182, September 14, 1965.

5. Report of the National Commission on Technology, Automation, and Economic Progress, Technology and the American Economy, Vol. I, February, 1966, p. 3.

6. Policy Planning For Technology Transfer, A Report of the Subcommittee on Science and Technology To the Select Committee on Small Business, United States Senate, Prepared by The Science Policy Research Division, Legislative Reference Service, Library of Congress, April, 1967, p. 2.

7. See full statement of Dr. Richard L. Lesher, Assistant Administrator for Technology Utilization, National Aeronautics and Space Administration, before the Committee on Science and Astronautics, U. S. House of Representatives, April 7, 1967.

8. Policy Planning for Technology Transfer, pp. 2, 4.

9. Ibid., p. 3.

10. Richard S. Rosenbloom, Technology Transfer--Process and Policy, July, 1965, National Planning Association, Washington, D. C., p. 34.

Appendix

1. Public funds generate about two-thirds of the available technology and the Government has a responsibility to get full benefits from this knowledge.

2. Federally derived technology has appreciable utility to industry and to other public programs at all levels of government. Well documented "second applications" are appearing with increasing frequency.

3. Therefore, Federal Government efforts are warranted in devising and operating programs to make this technology readily available to all users.

4. The private sector innovation rate is affected by a "climate" of which the availability of technology is an important part. Traditional sources of technology need to be expanded beyond the permanent staff capabilities of many firms.

5. Reeducation and counseling as to the technological needs of industry are necessary before strong demands for new information will arise. The Federal Government can logically participate in technical services but local and individual initiative will be most important in recognizing the potential for technology transfer.

6. At the present time, there is no uniform policy or practice among Federal agencies as to technology transfer. The NASA and AEC pursue a central-agency concept of collecting and disseminating technology. The DOD makes no special effort for the transfer of its majority share of Government-sponsored technology. The Office of State Technical Services concentrates on identifying user needs. The Clarification of Government responsibilities, including patent policy for R & D contracts, is essential to any expanded transfer programs.

7. Additional public discussion and formulation of opinion from both private and public sectors is necessary before detailed policy planning can proceed. The lack of "feed back" response from users of new technology makes difficult the evaluation of any particular transfer method. On going Federal programs should be examined more intensively for evidence of acceptance and efficiency.

SESSION NO. 3

ECONOMIC GROWTH STUDIES

Moderator:
Ira Horowitz
Professor of Business Administration
Indiana University

Discussants:
Richard M. Bailey
School of Business Administration
University of California

Edward F. Dennison
The Brookings Institution

IRA HOROWITZ

The subject of this evening's discussion is economic growth with specific reference to the effects of research and technology upon the rate and pattern of growth.

Most of us can easily name a number of companies whose spectacular success in recent years is attributable to a heavy emphasis upon research and technology--Xerox, IBM, Raytheon, etc. But it should also be noted that many other companies who have invested great sums in research have little to show for it. At the corporate level, it is quite clear that the general pay off from research and development (R and D) is not readily measurable: some companies invest in research and profit immensely therefrom; others invest in research and find it unprofitable.

At the national level of affairs, a certain mystique seems to have developed regarding the contribution of research and technology to economic growth. One might say that large numbers of people seem to place considerable faith in the ability of research to resolve many of our pressing problems. This faith in research and technological advance is found to be particularly strong among those concerned with regional economic growth.

In my own studies of the regional impact of research and development activities, it has been evident that there are, in fact, some benefits to regions that have developed strengths in this field. Many of these economic benefits might be thought of as multiplier effects stemming from R and D activity. In other words, the firm or university doing R and D not only receives a direct pay off from its output but also draws increasingly upon the R and D output of others in the region. Thus, so the reasoning goes, an initial base of R and D activity sets in motion forces which attract more R and D resources and a new growth industry emerges. Fundamental to this process, of course, is a strong demand for the results of R and D. In recent years this demand has been substantial--provided largely by the Federal Government.

My studies have indicated that the regions which have received a considerable quantity of R and D contracts have likewise benefited in terms of growing levels of employment, investment, wages and hourly earnings, etc. But when one focuses upon the issue of regional economic growth--at least as best as it can be measured using data extending from 1920-1965--it does not appear that a close relationship between regional R and D growth and overall regional economic growth can be found. Specifically, there seems to be no visible pay off in the form of higher rates of economic growth for those regions which have a growing R and D activity. The pay off that is visible, though, appears in the form of consistency in the rate of growth. Regions experiencing a steady rate of growth in R and D activities also exhibit steady economic growth patterns; regions which have little R and D activity have more volatile patterns of economic growth.

Generalizing from these observations, one might say that technology tends to be transferred quite sporadically between firms, regions, and even nations. Those firms, regions, or nations that are the basic creators of R and D benefit from their activities not so much by making great "leaps forward," but from finding a steadily growing market for their output. Others who consume the R and D created elsewhere, find growth more sporadic--the applications of the new technology do not evolve smoothly but in discrete, erratic packages. The result is that regions of the U. S. which have strong R and D activities have tended to show smoother rates of growth in value added output, employment, wages, and income than found in other regions. This is an interesting and probably important observation for those concerned with orderly expansion of the economy of their region.

R. M. BAILEY

Many Californians might take issue with Professor Horowitz's statements that regions with strong R and D activities experience smooth, orderly, and consistent rates of economic growth. The source of conflict would, of course, arise from focussing upon different time periods. Whereas it may be true that Professor Horowitz's data covering the period from 1920-1965 show good correlations between R and D growth and consistent regional economic growth, it does not also follow that this statement applies to year-to-year changes. I will talk to this point in greater detail in a few minutes but first would like to develop another thought.

A point that is often neglected when discussing the effect of research and technological advance upon the economy is in the area of demand creation. Most economists believe--in spite of our last few years of prosperity and rapid growth--that a fundamental problem of our economy is the maintenance of an adequate level of demand. There is the strong suspicion that much of the acceptance of the "new economics" is superficial and, in part, the result of a fortunate combination of economic and political actions. There is not much faith within the economics profession that the public or the politicians will support the correct mix of fiscal and monetary policy changes required to maintain vigorous growth if and when certain basic changes in demand occur. This means, then, that considerable reliance must be placed on the private sector in its efforts to stimulate demand--basically, new consumer demand for goods and services.

In recent years, we have witnessed tremendous growth in demand for new, high technology goods--demand generated by NASA for space exploration and the Department of Defense for more sophisticated weaponry. The industries which have responded to these demands have been located predominantly in California, the Northeast, and to a much lesser extent in scattered parts of the country. Accordingly, rapid economic growth has occurred in those cities and regions where these high technology industries have prospered. But one should not be unduly influenced by such short-run sprints in economic behavior. They are of marginal importance nationally, even though their effect upon certain areas may be of great significance momentarily.

The truly large markets in this country are for goods and services purchased by consumers. Typically these consumer expenditures account for 60-65 percent of GNP. The challenge for most companies is to develop and maintain strong consumer markets for their products and services. Because consumers have such a wide choice of alternative ways to spend their incomes, individual companies must continuously strive to make their products the ones that consumers will select in preference to others. The introduction of new and innovative products is the means most frequently used to create such demand.

Since the end of World War II, consumers in this country have exhibited a marked propensity to spend approximately 92-95 percent of their disposable personal income. The complement to these expenditure rates is personal saving rates of 5-8 percent. We all recognize that when personal saving rates rise, expenditures fall relatively and output, employment, and profits decline. Of course, some firms and industries are affected more than others, but nearly all move in the same general direction. Thus it behooves all firms to stimulate consumer demand in order to keep expenditure levels high.

The question that is often posed at this point is: "How does new product and new demand creation show up in our measures of economic growth?" The answer is: "Not very clearly or directly." Given this answer, one can see how difficult it is to measure the effect of research and technology upon economic growth because we must consider second and third order linkages. Moreover, there is the problem of substitution of one good for another. For example, we might assume that a new electric automobile is introduced on the market designed especially for urban driving. The first reaction to this new product might be to overstate its impact upon economic growth by looking only at the numbers of new businesses and workers who would become involved in the production, distribution, and servicing of these automobiles. But certainly, all of the demand for these new electric automobiles could not be counted as an increase in economic growth--one should consider the inroads on production and sale of gasoline-powered automobiles and the concurrent loss of jobs and incomes in these firms. The contribution to economic growth attributable to the new electric automobile would be the <u>net</u> increase in income after deducting all the economic losses from the economic gains.

At the present, our statistical measures of economic indicators cannot detect such changes in any very precise manner. We can observe the growth in demand and output in certain industries--and, if you will, focus most carefully on several of the new growth industries which are noted for their research and development activities--and also observe declining levels of demand in other industries which may consume very few R and D resources, and finally reach the conclusion that R and D is a very important factor in economic growth. But such reasoning is tenuous and cannot be supported by the data. We have very poor knowledge about the substitutability of demand of one product for another, our data on relative prices are weak, and little can be said (but needs to be) about shifts in demand from the private to the public sector and the effect upon consumer expenditures caused by a relative decrease in disposable personal income. Thus, although one may have a strong feeling that R and D is an important factor in economic growth, it is impossible to support such a conclusion given the scope and availability of our economic statistics. Thus, when we look at Dr. Denison's studies, we should not be surprised that he is unable to give much weight to R and D as a factor in economic growth.

Moving this argument one step further to embrace some of the findings of Professor Horowitz, it should be noted that any region is generally pleased to be the base for a "growth industry." A growth industry, after all, sheds many benefits upon a region because it provides the region with a competitive advantage over other regions. A growth industry enables the region to increase its sales, its exports if you will, to other regions and in so doing, attracts wealth and increases income in the favored region relatively more rapidly than--and in some cases at the expense of--other regions. California has benefited from the growing demands for high technology space and defense products in the mid-50's and early 60's. During that same period, the midwest--experiencing sluggish demand for its major export products, business capital equipment and consumer durable goods--became very envious of California's economic growth. Looking for a reason to explain their slower rate of growth, I'm afraid that many midwesterners have zeroed in on R and D as the answer. "If we could only build up our R and D strength, our economic growth would be like that of California" is the way it is often expressed. A deaf ear accordingly has been turned to the explanations provided by economists--even midwestern economists--who have taken the position that R and D itself is just not that important. Dr. Denison disputes the point using national economic data; Professor Horowitz notes that R and D doesn't cause more rapid rates of growth but may be important in making the rate of growth more orderly and consistent.

If one observes the performance of the national economy since about 1963, the conclusion could quite easily be reached that the midwest is now the focal point for economic growth. As aggregate demand has grown rapidly--with a particularly strong emphasis upon capital goods and consumer durables--those regions which have a heavy mix of such industries have naturally prospered. As private demand for goods and services has grown relative to public demand for sophisticated aerospace and electronic military goods, regional growth in the midwest and mid-Atlantic has surpassed that of California and other "high technology" regions. Unemployment levels reflect the differences most vividly: whereas the national figure has been in the 3.7-4.0 percent range for the last two years, the midwestern states have averaged close to 3 percent. California, meanwhile, has found it extremely difficult to get unemployment levels below 5 percent--even with its strong R and D base.

Two points should be stressed in summary. They are:

(1) The most fundamental factor in regional economic growth is the level of demand nationally. Policies pursued by government to affect the rate and direction of economic growth create the environment for healthy regional growth. Each region participates in national economic growth to the extent that the demand for the output of its industries is in a favorable or unfavorable competitive position. When demand conditions favor products with a high technology base, regions which have many industries producing for such markets may have above average growth rates. When demand conditions favor capital goods or consumer durable goods, regions which have a strong industrial base in these product lines may experience rapid economic growth. The converse applies also.

(2) When economists attempt to assess the impact of research and technology on either national or regional economic growth they are confronted with a difficult measurement problem. R and D can be either an input or an output in the production process--in most cases it is the former. There is the belief that those industries in which research is an output are becoming

relatively more important in the economy. This type of economic effect can be measured fairly well by observing data on the growth of such firms and industries. However, there is also a strong conviction among many that R and D is growing in its importance as an input in the production process. Here, the R and D input may be such as to create new products or to lower production costs and increase efficiency. These effects of R and D are very difficult to measure with our conventional economic statistics.

EDWARD F. DENISON

One of my recent studies has involved a comparison of growth rates in eight Western European countries and the United States. This study was undertaken partially as an extension of my earlier investigation into the sources of economic growth in the U. S. and partially to confirm whether the techniques of analysis used in the prior study could reasonably well explain the differences in growth rates among European countries and the U. S. The study is divided into two periods; 1950-1955 and 1955-1962. Later time periods would have been more desirable but the availability of comparable data limited the choice.

Although annual economic growth rates varied among the nine countries from a low of about 1 percent in Denmark to a high of 10-plus percent in Germany during the period 1950-1955, the measures employed consistently explained something over 90 percent of the variation in individual country growth rates. The unmeasured difference between the 90 percent figure and 100 percent is explained as due to factors that could not be directly specified--included therein would be the contribution of advances in knowledge of technological transfer. The significance of this roughly 10 percent deserves note for it implies that whatever the absolute contribution of these difficult-to-measure factors may be, they are not of major importance in explaining differences in growth rates. Indeed, one might conclude that the importance of these factors was very minimal because the technique of measurement employed could not account for the re-building of the economies of Germany and Italy which, in 1950, were still badly disorganized--and must have been of considerable consequence. Most of the unexplained contributions to growth in my study were attributable to the performance of Germany and Italy in the early 1950's and to later changes in the French economy for which no explanation can be found. My data, therefore, lead me to conclude that the impact of technology upon economic growth has not been very important in any of the countries studied--technology being defined as anything that advances knowledge of how to produce more efficiently, including R and D and anything else.

Another purpose of the study was to learn why post-World War II growth rates in European countries were generally higher than in the United States. Considering input factors first, some of the following observations were made:

(1) Labor. Germany had the greatest increase in employment of all nine countries studied; the U. S. was second. The increases in employment seemed to be determined largely by demographic factors that were unrelated to most other economic variables. In the U. S., employment increases were influenced heavily by growing labor force participation rates, particularly of women. Also, teenagers in school in the U. S. fill part-time jobs to a much greater extent than in any of the European countries thus adding to the labor force and employment.

Another part of the employment picture is the number of hours worked per year. In the U. S., in the period under study, there has been no decline in the annual working hours of full-time wage and salary workers. France was the only other country in which stable working hours of full-time workers prevailed. In Germany, there was a 13 percent decline in annual working hours of full-time workers from 1950-1962 and the trend appears to be continuing. In most of the other countries, the decline was on the order of 7 percent. (There has been a steady decrease in the average annual number of hours worked per worker in the U. S. but this is misleading because we have had a huge increase in part-time employment.) Considering the length of the work year, only France and the U. S. appear to have resisted increasing the number of hours of leisure time at the expense of reducing working hours during this period.

We generally think of education as an extremely important factor for its influence upon the quality of labor. The U. S. is notably the leader among all nine countries in this respect. The European countries which are achieving the most rapid increases in education of the labor force are Belgium and Italy. Paradoxically, Germany, which had the highest growth rate over the entire period, experienced practically no increase in the educational level of the labor force. The other countries fill in between these extremes.

(2) The importance of capital as an input to the growth process can be understood best by examining four different types of capital: housing; international investment; construction (including plant and equipment); and inventory investments. The U. S. led the West European countries in housing and international investment and rated relatively low with the other countries in construction and inventories. Overall, the U. S. had a below-average increase in capital inputs during the 1950-1962 period with the 1955-1962 being especially low.

Comparisons among countries on investments in capital are very difficult to make because of differences in relative prices of capital goods. In the U. S., capital goods prices are low compared to other prices whereas the observe case tends to hold in other countries. In an absolute sense, the U. S. was investing more than any other country during the study years but on a percentage change basis we ranked quite low.

If economic growth depended only upon inputs of labor, capital, and land and there were no differences in economies of scale between countries, Germany would have been the leading growth country, "par excellence," in the study. The causes would have been due to Germany's huge increase in employment and a very large increase in capital stock. Using the same input criterion, the U. S. would rank second. In actuality, the U. S. position was eighth among the nine countries.

Attempts to explain variations in the growth position of countries when more factors than basic inputs are considered hinge upon two "shift" effects. The first shift has been that of labor--from employment in agriculture to non-farm activities. At the beginning of the period, all countries had far more people employed in agriculture than were needed to produce virtually the same quantity of food--there was considerable room for productivity increases. The major factor determining the importance of this shift in employment was the percentage of the labor force engaged in agriculture at the beginning of the period. The range was from a low of 4 - 5 percent in the United Kingdom to over 40 percent in Italy. All countries reduced the importance of agriculture in their economy over the period but the effect on the growth rate was quite different in each country.

The second "shift" effect was much more predominant in West European countries than in the U. S. This was a shift of proprietors or unpaid family workers out of inefficient, outdated enterprises into paid, larger scale employment. As people were transferred out of these low output jobs or replaced with wage and salary workers in more productive businesses, total output rose substantially. The gains from such shifts were smallest in the Anglo-Saxon countries and largest in a number of continental countries. Reduction of trade barriers also appeared to operate in much the same way, allowing workers to find more highly valued occupations and jobs.

A final factor which appears significant in explaining differences in growth rates might be termed an economy of scale effect. In the West European countries in the early part of the period, many goods and services were produced in small quantity at high prices (in the U. S., these same goods and services were produced in large quantities at relatively low prices). There is a systematic and persistent difference between these countries and the U. S. on this matter. Many of these goods and services are income elastic and as European incomes have risen, consumption of these goods and services have risen markedly. It happens that many of these income elastic products are weighted heavily in the European price weighting structure. Thus, output increases in these countries have been inflated relative to output increases in the U. S. Adjustments made to the consumption part of national income and product data in these European countries result in a considerable lowering of growth rates with increases in per capita consumption making the U. S. growth rate compare more favorably.

DISCUSSION

<u>QUESTION</u>: Dick, in the U.C.L.A. model of the California economy, that is the growth model, one of the early conclusions was that with a lower level of federal expenditure, particularly R and D related, the California economy would grow more rapidly. Have you looked at that study and does it have any relevance to what we are talking about?

<u>BAILEY</u>: The study does have some relevance. One of the problems in discussing any region per se is what makes up its industrial base. The industrial base of the California economy happens to be oriented to the production of a number of products which have been in great demand in the post-World War II period. The California economy is particularly strong in the aircraft,

missiles and related components area. The question you pose is, "If California did not have such an industrial base, might it have grown faster?" Now, I'm not sure that one can make this conclusion because it must assume some very different things about the structure of the California economy. One has to look at the question in the sense of what California might export if we weren't strong in aerospace and related industries. We export a lot of agricultural products, but they are relatively low valued in comparison to value added in manufacturing. The California economy is really quite a complete economy in its balance of natural resources and all, but still, it's very dependent for its growth rate on being able to export products and services to other regions. It's pretty tough to expect that California can necessarily export other goods and services when you look at how relatively small the total population is in the West in contrast to markets back here in the midwest and East.

QUESTION: Isn't that a matter of diversification of industry too?

BAILEY: Diversification is important to lend stability to demand. But you are still limited by the total aggregate demand that may be economically feasible for your region to support. Outside of essentially exporting many goods to Oregon, Washington, Nevada, Utah and states right in that area, California cannot at this point in time, in my judgment, add a lot of new manufacturing establishments. There just isn't the demand in that region. So California's major export product has been selling to the United States as a whole; e.g. many varieties of defense and space equipment.

QUESTION: Are you considering that it's often reported that California receives more return on their federal tax dollar than the Midwestern states; consequently, the Midwestern universities are training technical people for export to California and are not importing in return to the educational institutions in the Midwest.

BAILEY: I think this was a particularly strong factor in the mid and late fifties and in the early sixties, when rates of growth and demand in California were relatively stronger than in the Midwest and certain other parts of the country. It's becoming increasingly clear now though, that as demand in other parts of the country is growing, we're starting to send some people back and export some of our graduates. But I'm not sure just what the balance is at this point.

QUESTION: Do you have appropriate measures for technological change?

DENISON: In a word, no. The most I personally try to get at is the contributions, from what I call advances in knowledge to the growth rate, recognizing that it's a rough estimate at best. But now the problem is what are these things. How do you measure them directly? The first problem you have is you don't know where they come from. How much of it is due to what you would call technology, how much of it is due to improved management practices, improved business organization, etc. There is no direct measure of achievement really in either field. R and D expenditures are a measure of input and don't tell you anything about what's coming out of the R and D. I kind of like patents better than R and D expenditures, but I can't say I like them much better. So my answer is, we have no direct measures.

<u>QUESTION</u>: Well, then we can conclude that R and D and technological innovation does not or does contribute to economic growth?

<u>BAILEY</u>: Let's look at an area in which I have been doing some work recently, in medical economics. Suppose that because of some advancement in understanding of the human body, instead of having to cut an appendix out, you could put a needle in and suck it out. I use this just for an example. Now assume also that the doctor charges the same price for the appendectomy, whether he makes an incision or just pushes a needle in. We have no way to measure the improvement in that particular advance. If he's charging the same price, and we label it as an appendectomy, then the economist will say that there has been no real change--no growth. You and I might say there has been a quality change or that there has been a change in the sense that now there aren't as many hazards in the operation. But we can't measure these charges with our current economic data. And that is one of the problems with the use of the economic measures that we have today. The change is something you have to measure in a qualitative sense, rather than in a quantitive sense.

<u>HOROWITZ</u>: I've been trying to get at this by measuring the number of scientists, either "en mass," or in various technical fields, on the presumption that all these people aren't "spinning their wheels." If you've got more people, then you have a better chance of getting something out. Of course that is open to the criticism that one smart guy is worth a lot more than ten not-so-smart guys. And you get into the problem of what are three physicists worth relative to ten plant morphologists, etc.

<u>QUESTION</u>: Ed, in your work, how do you separate advances in knowledge from education, since an advance in knowledge soon is added to the pool of knowledge, which is transmitted to other people through the educational process?

<u>DENISON</u>: This is a matter of classification. Before coming to how I do it, let me say what I'm trying to do. A contribution of increased education reflects increases in the quantity of education. That is, people going to school longer; becoming high school graduates rather than elementary school graduates; or college graduates rather than high school graduates. Nothing in the way I try to measure these changes reflects the fact that what's taught in physics or economics or any other subject today is not what was taught a generation ago. Whether advances in knowledge get disseminated through the schools or not, they still end up, in my estimate, as advances in knowledge. Conversely, it might be true that if you have highly educated people or more engineers you're likely to get more advances in knowledge. It's true this is not reflected in my estimates as a contribution of education, but as a contribution of advances in knowledge.

<u>QUESTION</u>: Does anyone want to comment about the possibilities or comparisons of how R and D affects the different types of economies, like free enterprise, government ownership?

<u>HOROWITZ</u>: Would the questioner care to comment on it?

<u>QUESTIONER</u>: What about the British gripe that so many of their scientists are coming to America? What effect does this have?

HOROWITZ: At least one British authority that I raised this point with told me that he thought that the "brain drain" from Great Britain to the United States was greatly exaggerated. What we were getting were the numbers and what Great Britain was getting was the quality. They are keeping the "brainier brains" and we were paying more money for the less potent.

QUESTION: Is that having any effect on the economy of Great Britain?

DENISON: I can guess that it's having an adverse effect. On the other hand, I don't know that it's any more adverse than in some of the other countries with a much higher growth rate. To explain the lower British growth rate, one doesn't need it. I know this is not a satisfactory answer, but I don't know how to get at it as a separate item.

QUESTION: Have you done any work on the impact of R and D and the resultant technology on creating a demand by consumers? It seems that the impression is that military R and D pays off by creating obsolescence very rapidly. You can't measure this kind of thing.

BAILEY: I'll revert to my medical economics and experience. There have certainly been a number of new break-throughs in medical knowledge in recent years, which have very definitely created a new market. Whether we talk about the heart-lung machine, or some monitoring system in hospitals, or "pace-makers," or whatever the case may be.

The questions that economists ask are: "If consumers increase their expenditures for these particular goods and services, on what are they decreasing their expenditures? Is there a new increase in demand that is generated by the new product?" Consider government expenditures for various kinds of missiles. The most measurable effects are, of course, the level of expenditures at a given point in time; or if government increases its expenditures for these particular goods; or if government may shift the mix of purchases of these goods. But it's the rate of change in expenditure that is of importance. Certainly individual industries are affected; they may benefit or be hurt by this change in mix of demand. On the other hand, remember that if the government is spending its resources--e.g. tax dollars, for these particular activities, someone who's giving up this tax dollar is able to spend less for some other goods and services. This might tie in with what I was saying about the Midwest in the late fifties and early sixties, in terms of shifts of demand. It may be that the shifts in demand do, in and of themselves, create some new growth in the sense that an industry that experiences a new increase in demand may go out and buy more capital equipment. The industry that is losing demand will probably be hurt both through obsolescence of its equipment and lowered profits but on balance capital spending may be greater than before the shift in demand occurred. One has to consider these changes in mix of demand in the context of what is the over-all emphasis for growth in the economy and what activities are being pursued in both the public and private sector to stimulate demand.

QUESTION: Mr. Bailey, isn't some of the increase in unemployment levels in California something similar to the draining of the "brain trust" from England to the United States? In other words, Midwest drop-outs go to California. If they hadn't migrated to California, the state would be better off and the rate of unemployment in the Midwest would be higher.

BAILEY: When one looks at the California economy, the people who are unemployed do not appear to be the Midwest drop-outs. They may be the deep South drop-outs, who have migrated there, and they are unemployed because the range of employment opportunities does not match their specific labor skills. If there were a larger over-all market in the far West for, let's say consumer durable goods, or for other kinds of services in California that could use more people with less training, I would expect that we would not have the high rates of unemployment that we do right now. Certainly one cannot expect that the kind of migration that has occurred necessarily generates enough demand in and of itself for the economy to be self-sustaining. That's why the California economy continues to be heavily dependent upon military and space expenditures.

COMMENT: Well, California is a glamorous country, you know. And a lot of people have gone there because it's a glamorous country. And yet, it's not a section of the country that produces basic products like automobiles, washing machines, etc., to supply the rest of the United States.

BAILEY: You are correct. Outside of food exports of California to the rest of the country, there is little else of basic private market products in the industrial make up of the state.

COMMENT: But production of food requires less and less labor.

BAILEY: This is true. So, again we come back to the fact that any regional economy that wants to grow has to have something very substantial in the form of an export industry.

QUESTION: Gerhard Colm, this morning, suggested a four and one-half percent growth rate in the GNP for the next ten years. Some computations on my part indicate that if we have a three percent growth rate between the year 1966 and the year 2,000, it would yield a gross national product aggregating for that period of something like 42.5 trillions of dollars. This is about three times the amount aggregated between 1929 and 1966. If we had a four percent growth rate, between 1966 and the year 2,000 the aggregate would be about 51.5 trillions of dollars, which is a difference of 9 trillion dollars. The difference between three and four percent growth rate is equal to about thirteen years of gross national product in 1966. I would like to know if there is a chance of achieving a four percent growth rate or even higher, or if it is coasting down to a level that is more consistent with our historical average which is about three?

DENISON: Considering that nobody knows, I think four and one-half percent is extremely optimistic, and I think even four is rather optimistic over the length of time being considered.

QUESTION: Well, would you think it was possible?

DENISON: This is an old argument I've had with Gerhard; how much difference the business cycle makes in fact. My own feeling has been that it makes some difference, but not a great deal; that is, the difference is in the tenth to two-tenths sort of range. Unless the burst of research and development spending has the effects which will yield enormously higher contributions in the advances of knowledge in the future, this seems to me that four and one-half percent is an extremely optimistic figure. Whether it's possible or not I can't say; it's probably not impossible.

QUESTION: Would you go along with Boulding and others who point out that currently there is a burst of education and a burst of knowledge which has probably reached an apogee?

BAILEY: I do not understand Boulding's point. As far as education is concerned, I don't see any acceleration in an aggregate sense. You have to remember that since about 1920, we've been having an enormous increase in the level of education. When I say there's no acceleration, I don't mean that the absolute level of education is not going up rapidly. What I am saying is that it is continuing to go up rapidly, but it has been doing so for a long time. What's relevant here is not the increase in the education of six year olds and eight year olds--it's the rise in the educational level of the people who are working. This depends on the difference between the education received by people who are now leaving the labor force and those who are now entering. The educational level of the labor force is determined in large part by what's been going on in the last half century. Even in the thirties, the quantity of education being given the young was growing. I expect it will continue to grow.

QUESTION: Dr. Denison, in reference to economic growth, there is a school of thought that says; the only way you can have continuous economic growth is to have some inflation all the time. Otherwise, you have depression. Is there any positive indication that we have to have inflation in order to keep the economy moving?

DENISON: I think all one can say is that no country I can think of has succeeded in maintaining high employment without some price increases. I don't think that this has very much to do with long-term growth. And there is certainly nothing in any comparative record that suggests the more infation, the more growth. But taking your narrower point on the business cycle, I think I would have to say it looks awfully difficult to avoid all price increase.

QUESTION: Well, isn't inflation more closely affected by the national debt?

DENISON: My answer would have to be no. The sizes of government surpluses or deficits which affect the change in the national debt are certainly one element in the picture. But they're only one element, and they have to be fit into the strength of investment demand, private savings, etc. I certainly couldn't agree with the statement that you just made.

HOROWITZ: In view of the inflated hour and the great debt that we owe to our discussants, I'll thank you all for coming and invite those of you who do have some questions up to the front of the room.

END OF SESSION

SESSION NO. 4

THE ROLE OF THE ENGINEERING SCHOOL

Chairman:
Thomas Coulter
Chicago Association of Commerce and Industry

Moderator:
Harold DeGroff
Executive Assistant to the Dean of Engineering
Purdue University

Panelists:
John A. Duffie
Director, University-Industry Research Program
University of Wisconsin

James T. Wilson
Director, Institute of Science and Technology
University of Michigan

Charles W. Mullis
Associate Director, Aerospace Research Applications Center
Indiana University

INTRODUCTORY REMARKS BY THOMAS COULTER

Welcome to the second day of the National Conference on Technology Utilization and Economic Growth. Yesterday, we heard a very interesting and provocative discussion from the social scientists on technology utilization and economic growth. Today, we are going to hear from the engineers. Engineers, are more or less reputed to be exact scientists and deal with proven concepts and concrete results. I'm hoping that today maybe those of us who represent the industrial interests here, and are looking for every way we can to transfer new technology into useful products and employment, will take something a little more substantive back with us.

We lost one of our panelists today. Dr. George Hawkins, who is Vice-President for Academic Affairs at Purdue, couldn't be with us. Filling in for him will be Mr. Charles W. Mullis, who is the Associate Director for ARAC.

ENGINEERING FACULTY RESPONSIBILITY IN PROMOTING TECHNOLOGY UTILIZATION AND ECONOMIC GROWTH

By

John A. Duffie

I. INTRODUCTION

During the coming 30 minutes or so, I shall explore some diverse questions of policy and practice in universities, some aspects of federal policy, and certain industrial attitudes that affect what the engineering faculty member does. Only in the light of these broad considerations can engineering faculty responsibility for technology utilization and economic growth be discussed. In these lights we can see if the professor is having the desired effect, and if not, what might be done about it.

It must be recognized at the outset that the term "Engineering Faculty" covers a tremendous diversity of individuals engaged in many diverse activities, and located in institutions of widely varying nature. Each college, within its faculty ranks, will have professors whose interests will lie predominantly in one or the other of the areas--teaching, research, and public service. Thus it is only possible, in a short time, to refer to trends and "representative" professors. This diversity, needless to say, is an asset to be preserved.

The primary customers for the products of the engineering college--industry--are more variable than are the professors. Needless to say, industry's attitude toward new technology varies through a complete spectrum--from complete apathy to vigorous participation in its development and use.

(Incidentally, I am equating economic growth with industrial growth, and accepting the notion implied in the meeting title--that economic or industrial growth stems from technology utilization.)

Now, we proceed to the basic questions: What are the relationships between the engineering professors and industry? Are they satisfactory, or are there improvements to be made? Let us look first at the Colleges of Engineering in the universities, and then at industry.

II. ENGINEERING COLLEGES

It is the nature of the modern college of engineering (and particularly those we might refer to as the major colleges) that they combine undergraduate and graduate teaching programs with research. I suspect that most colleges giving the BS in engineering aspire to MS programs, and most with MS programs aspire to PhD programs. A very substantial and increasing number of the good BS graduates of our colleges go on for MS and PhD degrees. Under these circumstances, research becomes an increasingly important responsibility of the engineering faculty.

How does this emphasis on research fit into the generally accepted pattern of faculty responsibilities? At Wisconsin, we refer to three phases of this professonial function: teaching, research, and public service. In other words, these are: the development of new knowledge; the dissemination of that knowledge and the "know-how" behind it via students; professional societies and publications; and rendering of public service.

The engineering faculty is generally composed of people who are pretty much on the forefronts of developments in their areas of specialization. Thus they are in a unique position to advise and assist local and federal government agencies and professional societies, and otherwise render what we refer to as public service. Hopefully, what the professor does in this area is closely related to his competence as an engineer and researcher.

In the ideal situation, the teaching and research functions are very closely intertwined. Research carried out by the PhD student with his professor is a form of teaching on an individual level. The knowledge they develop together feeds out into the technological community and also back into the graduate and undergraduate coursework. The next question, then, is--what is the nature of research going on in our engineering colleges, and how does it relate to industrial growth?

To a very significant extent, the research efforts of our engineering faculties have been science-oriented in the post World War II era. To quote from W. R. Marshall, a professor of chemical engineering and former president of the American Institute of Chemical Engineers[1]:

> "<u>A third influence has been a substantial retreat from engineering research</u>. This has been produced by the faddism that only basic research in science is important and worthy of support; research must not be applied or have a useful goal. The engineer in research

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[1] W. R. Marshall, Jr., "Science ain't everything," <u>Chemical Engineering Progress</u> (Vol. 60, No. 1), January, 1964, p. 19. (Originally presented at the Annual Meeting of A.I.Ch.E., Houston, Texas, December, 1963.)

has had to imitate the research of science and his research proposals have had to satisfy scientific rather than engineering judgments, resulting in nitpicking trivial problems in order to satisfy a criterion of having no immediate useful purpose.

"The dominance of science in government research support programs has stifled the stimulation of imaginative, vigorous research in engineering with distinct goals of application and usefulness, resulting in unknown losses to our economy through the slowed up growth of new technologies..."

Marshall goes on: "<u>The science syndrome among some of our engineering faculty has resulted in engineering graduates being unprepared and unmotivated to participate in the real world of engineering practice</u>. They have not been taught that 'science ain't everything.' That although it is and should be a fundamental starting point, it does not always provide needed answers when the engineer passes the borders at the frontiers of science and is required to extrapolate his knowledge and to use judgment in solving new engineering problems. Too often the engineering student's education has not emphasized that an engineer cannot afford the luxury permitted to the scientist of waiting indefinite periods for the evolution of new theories or for critical experiments to push forward the frontiers to solve a problem. They are not always taught that the engineer must, in some way, solve the problem he faces today--he cannot face it boldly and pass it by--nor can he wait several years for science to produce the necessary theory, or select another problem more susceptible to solution."

Two points are made by Marshall. First, the availability of federal funds for research in engineering with a strong science slant has moved engineering colleges in this direction. Second, while engineering education has benefited from the emphasis on science, engineering is based on more than science, and re-emphasis on engineering <u>per se</u> is needed.

These thoughts are germain to our basic issue of economic growth. If in future development of our engineering faculties we can add people with strong interests in industry and its problems, people who will in turn produce students with these interests, the rate of infusion of new technology into industry will certainly be enhanced. In other words, we should be developing more of our engineering faculty to be preoccupied with industrial problems and with the usefulness of their research to a producing enterprise.

In advancing this thought, I should add that our professors by and large are a select group with unique capabilities for independent and forward-looking contributions. I am convinced that the professors' activities should be in keeping with those capabilities, and that he should not, in general, concern himself with mundane and routine problem-solving for industry. That is better left to those whose business it is to provide these kinds of engineering services. Better that our professor tackle the problems where his experience, creativity, and originality are essential ingredients to solutions.

III. INDUSTRY

It is more difficult to characterize industry than colleges. However, since my topic here is the role of the engineering faculty in economic growth, I can restrict my comments to that segment of the industrial community which deals in processes or products having a high technology content. This is the industry having problems that can challenge engineering professors--if the industry and the professor recognize the problems.

The range of attitudes in industry toward innovation and use of new technology includes apathy, antipathy, and ignorance on the one extreme, at the other eager pursuit of both development and use of new technology. Industries having the latter attitudes, the more aggressive and progressive industries (in a technological sense), are not our worry, but in varying degrees other industries are not stimulated to seek new technology. Therein lie the problems.

Industry bears a range of attitudes towards engineering colleges--almost as wide as those noted previously towards innovation. As some industries are uninfluenced by new technology, some are also uninfluenced by contacts with engineering professors, and a major source of strength in development of future business goes ignored.

The reasons for industrial indifference to universities are several. Many don't know how to work with the faculty, or are displeased at lack of faculty interest in their problems. In the case of many, management feels they are supporting the schools via the tax route. There is disappointment that graduates gravitate to "glamour" industries and are so difficult to hire. There is widespread failure to understand what a university is and what it does, and we in universities have not made our capabilities and limitations sufficiently clear. The professors' preoccupation with "basic" research, without thought to its utility, has been a source of dismay. There have been implications from some quarters that the universities were the source of "all solutions to all problems," but it is clear that we cannot be all things to all people.

The support by the federal government through the National Science Foundation of basic research has been highly successful and commendable in improving the science base on which engineering can draw. NSF, a relatively small federal agency, last year awarded more funds to colleges and universities than all of the business corporations in America. While accomplishing its commendable aims, the emphasis on basic science has been a factor in diminishing interest in our faculties in applications of science.

Other areas of difficulty between industry and the colleges of engineering lie in the problems of proprietary rights and patents. It is the nature of the University that what it does is open and available to all, and that freedom of the graduate students and professors to discuss their research is critical to the educational process. Industrialists, intent on gaining competitive advantage, can hardly be expected to respond with enthusiasm to the idea of open exchange of information on problems they might want to bring to the campus. Again, we have perhaps not made clear the limitations of the universities in handling these proprietary matters, or the possibilities of use of professors in a consulting capacity as resource and idea people. In a more positive sense, we should seek out more of those industrial problems that are good problems for engineering graduate students.

(There is a segment of industry I have ignored here, and that is industry with little or no research orientation. While there need to be mechanisms for technology to reach this industry, I think this often goes beyond the responsibility of the professor of engineering. Out of STS and similar programs will evolve the means to keep this segment of industry aware of developments that will affect it.)

IV. CONCLUSIONS

A higher degree of interaction between industry and engineering faculty members should result in strengthening of industry and economic growth through better technology utilization, and not, incidentally, engineering education. I feel strongly that we should be seeking this improved interaction wherever it is appropriate. Accepting this, what needs to be done in government, industry and colleges to bring it about?

Government, in cooperation with existing state, university and other agencies, can assist in developing information services and continuing education programs which will assist the engineer in industry to find, digest, evaluate and possibly use the huge mass of technology being developed. Along other lines, federal agencies supporting research in universities should recognize the value of applications-oriented research in our colleges, and lend support to it in addition to support of basic research.

Industry and engineering colleges need to establish (or reestablish or strengthen) a strong working partnership that is implied by the definition of engineering. Industry has, to a significant degree, defaulted to the federal government in support of colleges, and I suggest that it should reevaluate the merits of enlarged support of engineering education in areas of company interest. Industry should seek close ties with the faculty, to be aware of and possibly participate in research in the colleges, and call on the professors as resource people in their areas of competence.

Colleges of Engineering, for their part, should strengthen and develop strong components of applications-oriented faculty. As new staff are added in the future, the colleges should be more willing to tackle "new" problem-related research, and perhaps in the process they will revitalize student interest in industry. It is desirable to have a degree of entrepreneurship in the faculty. Most important, a lively interest in industrial problems of a challenging sort will keep the professors in touch with industry and their research and teaching most effective in achieving economic growth.

SUMMARY OF REMARKS BY JAMES T. WILSON

Dr. Wilson began by endorsing many of the remarks by Dr. Duffie and focused on the responsibilities of the engineering schools and science departments in their role in economic development. He rephrased the research, teaching and service to community responsibilities of the University as generation, transmission, and preservation of knowledge, and suggested that in the presence of these, engineering schools in particular should not lose sight of the applications responsibility.

He pointed out that the primary outputs of engineering schools were students and knowledge. Their role as a source of existing knowledge may not be fully appreciated by the schools. He commented on curricula reflecting the interests of faculty and the systematic inertia which tends to perpetuate the existing offerings. Fortunately, recently, universities have begun to look inward to examine this situation. However, often the motivation for this is decreased budgets rather than academic excellence.

He then discussed the emerging interests in continuing education. Often in these course offerings a more modern subject material is covered than is covered in the regular curriculum. In other words, industry demands newer technology than that offered the regular student. The research effort of the school must have this as a normal output. He pointed out that sometimes the standard curriculum just does not fulfill the needs of industry. He cited an instance where the University of Michigan closed out their department dealing with machine tools only to see the emergence of complete new technology in the area such as numerical control and automation techniques. Consequently, the department was rebuilt but the textbooks were thrown away. He commented on the fact that engineering research did not match well the needs of industries because so much of it is mission oriented, federally sponsored research. Students who work in these programs do not come out mentally set to work for a power company or a machine tool company. The availability of sophisticated research tools (expensive laboratory equipment) greatly influences the students choices here.

He cited a major short-coming of current educational policy as that of turning out students oriented to the current problems, military and space. A real need exists to be training now the engineers who will solve the public works, pollution, flood control and possibly weather control problems which the federal budget will surely be directed toward once military committments can decrease.

A ROLE THE ENGINEERING SCHOOLS SHOULD ASSUME

By

Charles W. Mullis

First of all, let me say that it is extremely presumptuous of me to sit on a panel with this group of distinguished people. I guess "fools rush in where angels fear to tread," and being an engineering school drop-out, that gives me a license to do this.

My remarks here will be more in the line of a role I think the engineering schools can or perhaps should play. I don't believe there would be a need for a technology utilization program sponsored by the government or governments, if the educational process were being adequate. I'm referring here of the classical educational process.

Professor Wilson commented about the role of the engineering school in generating knowledge and in being a source of knowledge. It's a key consideration that the engineering schools are generating some knowledge, and they are being a source of some knowledge. I'm not sure how much the engineering schools are doing to order the knowledge that is generated, or that lies in their file. Do they have a concerted effort to collect the knowledge generated elsewhere?

As we look at people who are involved in information services among the various companies that ARAC is working with, we see a distinct group of chemists who are involved in information processing activities. The chemists have a unique problem in classification of their various compounds, etc. It was identified early. They did not sit back and wait for the librarians or the information scientists to start ordering their information; they rolled up their sleeves and got into it. I think this is germane to the point here that the engineering schools, almost catagorically, have not rolled up their sleeves and gotten into the problem of ordering their knowledge so that it is accessible and retrievable. To quote Julian Huxley, "Mountains of facts have been piled up on the plains of human ignorance. The result is a glut of raw material. Great piles of facts are lying around un-utilized, or utilized only in an occasional and partial manner." I think that's the real sin. The knowledge is there, but we don't have it ordered in such a way that it's easily accessible.

There is another whole area here concerning training our engineers to be information conscious which is very important. It's very relevant to curricula content. It's a point to which engineering schools must seriously address themselves. What information training should you give an engineer? My former boss here at ARAC has said, "But it's so much more fun to re-invent the wheel than to read about somebody else doing it." Well, it's something that we can't afford. We have to teach our engineers to read. We have to teach them to be information conscious, and then provide them with an ordered source of information from which they can retrieve facts.

Professor Duffie and the others have pointed out the breakdown in communications between faculty and industry. Part of this may be because the facts that are known by the faculty are not ordered in such a way that the industrial man can come and get uniquely to the information he needs. The faculty man may have a right to be unconcerned about this, because he already has these facts in his billion-bit memory file; and he's not concerned about getting these to an engineer who's out there solving a problem. He's concerned about generating more knowledge and shaping the young man who can go out. But someone has to be concerned about getting the information out. The responsibility may rest with the management and administration of the universities.

One final point, for many years, traditionally, universities have provided sabbatical arrangements for their professors to go back and get themselves retreaded; to refresh themselves; to take a new look at their research, their teaching, their various interest. I think that it's a management fault that industry is not seriously looking at this method of continuing education on the part of their own engineers to keep them up-to-date; to keep them in the spirit of their times, rather than to let them fall behind the times. It's impossible for a person to learn a profession now days that won't change within his own lifetime. If mechanisms are not provided to keep one up with change as it occurs, then he's going to fall behind the times.

So, I would see that a major role that engineering schools must address themselves to, in the years to come, is not only the generating of knowledge and the being of a source of knowledge, but the ordering of the knowledge that is existent, so that it is available to all of those who have a use for it. Industry must assume part of the responsibility for going after the knowledge that is made available.

SUMMARY OF REMARKS BY HAROLD DE GROFF

Dr. DeGroff commented that with one exception the other speakers had covered the points he felt should be emphasized. That exception concerned the process of industry "closing the loop." For this purpose he limited technology transfer to the utilization in the civilian economy of the results of military and space research. He questioned the ability of much of civilian industry to exploit the available technology. On the subject of ordering information, he suggested that there is a considerable divergence in the amount of ordering the faculty man sees as necessary and the amount the company engineer feels he needs.

He pointed out that despite the efforts of services like ARAC provides, many engineers in industry have not determined how to avail themselves of information laid in front of them. There is a translation problem. Although the students were exposed, as Professor Wilson pointed out, to the space and military technology, some wind up in civilian industry. For some reason they don't know how to translate what has been done into solutions to their problems.

He suggested that it is not enough for the university to cross the street. The university and industry must meet in the middle of the street.

DISCUSSION

QUESTION: We've heard a lot about the glamour phases of research influencing where our engineering efforts are leading the interests of the student. When I went to school, there wasn't any such glamour situation. It was engineering that was glamorous. I think it's a defect and a weakness of the faculty that they are not now able to make ordinary engineering glamorous. What is the answer?

DUFFIE: This is a critical problem. I don't think it's quite that simple. It's a matter of the faculties being capable people, with a diversity of interests in the areas where research can be supported. Over the years, we have seen a situation where there's been a tendency, because of the availability of funds, to work in areas that are probably not particularly germane to the glass industry, for example.

COMMENT: I didn't mention glass.

DUFFIE: Well, alright. The students and the faculty are responsive to the challenges of the space program. This is tremendously exciting. I'm excited by this. I don't think our people would be human, if they weren't. They want, if possible, to participate in these programs. In a sense, the more mundane companies, are in competition, tough competition, for the attention of the public, for the attention of the students and the faculty. As far as I've been able to see, a lot of our people have grown away from very many contacts with industries. On the other hand, industries have made very little effort to stay in contact with many of our people. I guess I have to accept some responsibility for this in universities, realizing the reasons for it. But I think, along with this, industry needs to stay a little closer to the universities.

DE GROFF: I did a little homework before attending this meeting, with respect to my own institution and with respect to the character of support of engineering research, because as you've heard here this morning, many people indicate that this has some bearing on the problem that you've mentioned. Purdue's budget, or available funds for engineering research and development within the university, this current fiscal year, is just a shade under five million dollars. Purdue is not the biggest in this particular area, but it's certainly some where among the top ten or twenty. Eighty one per cent of that money comes from the federal government of which sixty four per cent comes from the Department of Defense and NASA; and the other seventeen per cent comes from the National Science Foundation, the National Institute of Health, etc.

Perhaps more germane is the fact that of fellowships and traineeships, seventy six per cent of the money comes from the federal government. It's pretty well cast in the types of programs in which the federal government is interested. Now that would seem to leave a lot left over, except the other nineteen to twenty per cent includes state and university funds. The industrial component is extremely small.

Another related point is that these research funds, whether they come from DOD or NASA, have built into them a very important dialogue. The professor and the students, in some very direct fashion, are completely involved with the agency that has given them the money. There's their counterpart in the federal agency, whoever it may be, who's vitally interested in this problem. And I think you know, nothing fascinates technical and scientific people more than the chance to argue with somebody who's equally concerned with their particular problem. If you look at the industry money, industry with the best of intentions, by and large, stays within its own walls and gives the universities unrestricted grants, some of it in pretty significant sums. But having done this good deed, it then goes its own separate way, believing that this is exactly the kind of thing that ought to go on at a university. The dialogue comes to a halt right there. So you find the university faculty and students interested in what their contemporaries in the government are interested in, and not interested in the industry problems. Somehow the dialogue must commence.

COMMENT: But the reason industry does this is that industry employs other people, other than technical people.

DE GROFF: Yes, but our point is that if you are to get the faculty and students interested in your problems, they must somehow become a part of your outlook on these problems. And if you give them the money and go away, I'm afraid that this will not happen.

WILSON: We run some rather large research laboratories at the University of Michigan. Our biggest one has an annual budget of around thirteen million dollars, mostly from DOD and NASA. It gets involved in fairly large problems. We've had no trouble getting students and faculty heavily involved in what would be considered unglamorous types of engineering; where they're involved in some overall program, you know--mechanical engineering problems, lens design problems, things that we sometimes say, "oh well, the engineering students won't pay any attention to these; they won't want to work on these problems." It isn't micro-electronics or something. They will, if the support is there and if it's part of an overall mission. They'll work on it in a very innovative fashion, because there is both the support and problem. Maybe what we have to do a little more of is to make sure there is a little broader range of problems available in the sort of research and educational part of the engineering schools.

DUFFIE: We have some examples in the last two or three years at Wisconsin, where this dialogue that DeGroff speaks of between industry and the university has been established and has been successful. For example, in the field of rotating electrical machinery; not usually thought of as a glamour industry. This can be done. This is the kind of thing that we have to see.

COMMENT: I'd like to address myself to your request that we try to close the loop. I would assert that the loop is never going to be closed with paper. The loop is going to be closed with people. Specifically, it's going to be closed with people moving back and forth between the military-space sector and the civilian sector. There's an assumption that I analyzed very much, namely that somehow or other, when a young fellow gets out of a university and goes into the military-space industry, he's lost to civilian society forever. It seems to me it's a very fundamental assumption and we should check it out. In my study, we've talked with a couple of hundred engineers and scientists. In all that time we ran across about two dozen or so who had actually moved back from the military-space industry into civilian industry.

There are a couple of very interesting things that I observed. These people are extraordinarily able people, and they were in positions of great responsibility. This is not only the situation in industry, but is also now the situation in government, where people in DOD are moving into the socially orientated agencies. I dare say that you have a few of them stomping around your own premises here. And I should think that we should get some very interesting observations, if you can persuade them to talk.

The simple fact is that we don't know how many people there are doing this. We don't know what they bring with them. So, I would think it under the first order of research business that we ought to get on to this question and find out just what, in fact, is happening. We may find out that the military-space program is the best engineering training school we could ever design, and that it couldn't be any better if we sat down to draw it up. I wouldn't want to put my money on that proposition, but then there is at least that possibility.

COMMENT: I would like to support a move that you mentioned a minute ago that we're going to have to find a common meeting place between the university and industry. And I think DeGroff, that you're too modest to tell us that you've tried to accomplish this in a small way at Purdue, through the establishment of an independent profit making organization which exists essentially on the campus where professors and graduate students in engineering at the university can work on the practical problems of industry on a confidential, proprietary basis. Now this is one little mechanism. Hal DeGroff's organization is not large, but it's very significant. Incidentally, Purdue saw the need for the establishment of that kind of a bridge between Purdue and industry, particularly in the state of Indiana. The Purdue Research Foundation took the leadership in helping to get this organization started.

This is a function that the non-profit research institutes can also perform, and should perform. And I hope we can talk a little bit about that Thursday morning. I feel that we need to look for mechanisms for bringing the university and industry together. We can accomplish then what Sumner Myers would like to have accomplished. The University can bring with it to the market place the contacts and the knowledge of government research.

I would like to comment briefly on the remark that Professor Wilson made on the function of the university: to preserve and create and to transmit knowledge. In my opinion, the university has acquired a fourth dimension: to lead in the use of knowledge, as well as in the other three traditional functions of a university. This is partly what we're talking about this morning. The university has demonstrated real competence in certain professional areas. In agriculture, for example, in medicine, in pharmacy; and I think at one time in engineering. But I don't believe universities today generally are taking a position of leadership in engineering technology and the applications and the use of technology that should be a major responsibility and function of a university; particularly a state or publicly supported university. More and more, they're all becoming publicly supported to a greater and greater extent. This is one thing I find almost lacking. Perhaps it's hidden, but professional engineering education seems to have gotten away from being a profession, in the sense that a profession is keyed to service to the community and to humanity. We have put in engineering, too much emphasis on the scholarly research and the scientific side of engineering and too little on the practical application, the use; which to me, is real professional engineering. I hope that in planning engineering for the future, we can think more about that; that we can get more of this built into our thinking and planning.

COMMENT: I've heard this subject discussed for years about the need for greater liason between the university and industry. But nobody seems to want to take the lead. The universities feel that well, it's up to industry. I'm amazed that someone here criticized unrestricted grants, feeling that they should be restricted thereby getting better liason between industry and the university.

QUESTION: Who should initiate the leadership?

COMMENT: This begs the question: How do you motivate a faculty toward applied engineering when the academic, professional reward structure clearly favors scientific research? The academic community tends to regard consulting as engaged in principally for monetary gain by the individual. Promotion committees tend to regard consulting as more of a negative factor that takes away time. Perhaps we need to shift the carrot in the reward structure.

You mentioned originally the objectives of the engineering school as teaching, research and public service. But actually, you reward based on research. We're going to have to shift that carrot to the public service area through implementation and application. It's just like telling a factory manager that we want high quality products; we want them fast; and we want all we need when we need them; how we need them; in what quantities we need them; and we're going to promote you on the lowest unit cost.

DUFFIE: After some years, we finally got consulting to be a respectable activity at our university. We've convinced the administration that it's not only a good idea to help keep their people; but it strengthens the process of engineering education. We encourage our engineering faculty to consult. Likewise, we encourage companies that come in and want some kind of cooperation or assistance from the university to hire our people as consultants where it's appropriate. We don't consider ourselves a consulting bureau; but nevertheless, this is the way the job is most effectively done.

QUESTION: Do you promote them on the basis of that consulting? Do they get higher or more special ranks for the more consulting they do?

DUFFIE: That's an extremely difficult question to answer, because the various inputs to the process of promotion vary from one department to another. It depends on who's concerned. This is also a matter of the instructor and the particular institution. Consulting is neither a positive or negative factor in promotion at the university level. It might be a positive factor in the departments; but in the divisional structure that we have, that finally passes on promotions, it would not be a factor.

QUESTION: I think that industrial research is just as glamorous as NASA or DOD or anything else. You're doing essentially the same things; but that's where the dough is, and it's easy money, and that's why you're there. Why don't you go out and get private industry to invest more money in research at your universities?

DUFFIE: I think that's an excellent idea.

QUESTION: Alright, but I'd like to get this question about initiative answered. Who does this?

DUFFIE: I think that the programs such as our university industry program, Hal's Midwest Applied Science Corporation, and Jim Wilson has an arm in his organization that functions essentially the same way, are an effort to exert the initiative. The universities have for the last four or five years demonstrated a very significant initiative in this.

QUESTION: Could we have one example of that?

DUFFIE: The university-industry program at Wisconsin has half a dozen faculty people who have time available to go out and ring the doorbells of state industry, to find out what's going on in those companies and to bring those people into the university, when it appears that we have interests in common.

QUESTION: You mean you're actually going out and taking the initiative in calling on industry?

DUFFIE: Correct.

COMMENT: In my opinion, the Office of State Technical Services sought to support this kind of a thing. This is really the purpose of the State Technical Services Act. This is what STS ought to be doing, in part at least, supporting these mechanisms like Midwest Applied Science Corporation and the sort of thing that was mentioned in Wisconsin.

WILSON: We spend quite a little university money in "ringing doorbells" as Jack says. Engineering schools are shifting a little bit again on the consulting question. I have made it considerably easier for faculty members to carry on some consulting, and still maintain their faculty respectibility. A lot of our university engineering professors are on eighty per cent appointments or something of this sort, because of their consulting.

We recently had an all-university questionnaire, trying to find out about faculty attitudes. It was interesting that in the question where the faculty was asked, "How do you think your chairman and your dean judge people for promotion?" the faculty did not think the administration weighed research as heavily as most of us would have thought the faculty would have said. A separate questionnaire was also sent to chairmen and deans, and I'm sure one would expect them to answer, "Of course we treat teaching as the most important thing." On that questionnaire, one would draw the conclusion that teaching and particularly service was weighed probably somewhat more heavily than the faculty in general would have thought to be the case.

Engineering schools are facing up a little more to the fact that the real basic involvement of the engineering school with industry is going to have to come through faculty interaction. You're going to have to get consulting going in some fashion that will lead to this involvement. Things are a long way from perfect, but things are considerably improved in this regard, over, say ten years ago.

QUESTION: What can the universities and engineering schools do to further the cause of technology transfer. The panel has pretty well pointed out, I think, that there's a need for this sort of thing; that we may not be doing a very good job right now. Dr. Wilson pointed to the summer short courses that are heavily weighted on the side of new technology. This is good certainly, but what seems to be needed even more than a specific technology course, is a course that will help participants to learn to think in terms of the wide range of technology that's available to him; and how to get access to it. I don't think we're doing a very good job of it. I'd like to ask for comments specifically: what is being done in this direction now; or what can and should be done to prepare our graduates to make better use of existing technologies. This is particularly important in the light of the great recent increase in such technology, and the fact that it's probably going to be still more important in the future. What are the universities represented here doing now?

MULLIS: There are some real significant points that I tried to bring out in my opening remarks about the fact, that the universities are generating some knowledge. They are a source of some knowledge. There are other agencies and organizations that are generating knowledge, that are also sources of knowledge. If we take knowledge as a total pool--as a total set, all of these various sub-sets must find their place, they must be ordered.

I don't think it's right to put the onus completely on the back of the university. I'm a little bit concerned about the nature of the conversation we've had here about these things. I think transfer is a two-way street. As Professor DeGroff pointed out you have to get industry to ask. There's an education problem here. Many people have said that ARAC faces primarily an education problem. How do you educate the man to ask the question of the file where the facts are contained? Perhaps we need a course; maybe it's a summer short course, in this area.

COMMENT: Full burden is on the university. But let me say that this transfer of knowledge from the research lab to the user might be thought of in terms of chain lengths. There's a generation of knowledge; there's the gathering it and putting it into information banks, of which there are a number. It's transferred then, to a regional dissemination center, and finally gets to the user. Mr. Mullis was talking about how you get the information generated in the university into the information bank. And sure, that's an important part of it. A weak link in this chain is the user himself. That he has to learn to think in terms of using additional information, using existing information, instead of re-inventing it himself. This is an educational problem. Maybe it's not the function of the university, but that of the user and his manager who has to spend money to do this sort of thing. Of course, he spends money whether he realized it or not, because people are picking up information. But it seems to me, that there is an education that's got to be done.

MULLIS: I think there are two points to this, Professor Teare. Dean Hawkins has suggested that engineering curricula need to include a course or course structure which makes the fledgling engineer receiving his Bachelor's degree more aware of the problem of information processing, and how he obtains his information inputs. There is the additional problem: how do you train the engineer who is out there fumbling around trying to find out "who in the devil can I ask a question of, so that I can find out whether or not something exists." They're two different problems.

QUESTION: That means there's a continuing education level, possibly a graduate level, possible an undergraduate level. And some of that, I'm sure, is the responsibility of the universities. Is anybody doing anything about it?

WILSON: A little of this is going on at Michigan. There has been considerable concern in the Engineering College at Ann Arbor in the last few years. The students, in their normal course work, don't get at the total use of information. One thing that's been done is that they've developed several special problem courses - seminar type courses, usually at the senior or first year graduate level, in which a collection of a dozen or twenty students are given some monstrous problem, which they're then to attack and come out with some solution. They are given a great deal of help to get them at all the sources of information. These have been fairly successful and have tended to get the engineers out of the "over-sciency" part of their program, and out of the routine textbook.

A lot of data that they have to go get is data that is in government contract reports, for example. One of the problems they did recently was the design of a system for a polar satellite for data collection. Another one was a big, automated inter-state highway system. But practically everything they had to dig out for this came from the standard government contract reports and current literature.

I think they're aware of this problem. But they're hung up a little bit at the same place we're all hung up. The volume of raw knowledge has gotten too big for the old traditional engineering handbook, and we haven't quite found out a way to get it in the form that these students can get at it. They've outgrown the engineering handbook. Now where's the next step. The engineering schools are not forgetting this. They just haven't really gotten a handle on it yet.

DE GROFF: Isn't one of the problems that we're involved in asking questions about, the innovative process itself. You want to know how, really how, people go about the job of innovating. There was a federally supported project called "Project Hindsight." One of the questions was: if we take something in being and we go backwards from its present state, do we pick up any clues as to how the technology transfer and innovation took place? I gather that many of the results of "Project Hindsight" were negative. It was pretty hard to locate how things filtered in. Things come from so many different directions under so many different stimuli, that it's hard to say.

COMMENT: It's an unconscious process in a large measure, I suppose. I should think as teachers we ought to worry about whether we can do better than that, in the same sense that we can do better by designing than by just letting people do it by a hit or miss process. We ought to be able to figure out ways to help them learn how to use the information banks.

DUFFIE: This is inherent in our undergraduate and graduate courses. When we give courses in Chemical Engineering at Madison, it's a rare one that doesn't require the students to goto a variety of sources. This inquiring type of mind you are seeking is what we attempt to build in. How successful we are may be another question. You were probably originally speaking of an engineer in industry. How do you get to these people? How do you build this kind of an attitude in people who have been working for ten or fifteen years? This is a much more difficult problem, and in essence, is the heart of our program at Wisconsin. It's an educational problem to get people interested in and aware of what is available to them. Our particular source that we have to work with is the faculty of the university and what that represents. But when you've got an answer to that question, I think you've got an answer to a great deal.

COMMENT: But don't forget the people in industry that you're trying to reach are people that were previously your students.

WILSON: This is correct.

COMMENT: This is both a question and a suggestion: The proposition is accreditation of colleges of engineering. The academic influence is the greatest in the examination. Industry is invited to participate in a minor role. Greater voice by representatives of industry would be a powerful method of influencing universities. A two year accreditation where a program has previously been on a five year plan, might have a great influence on the way that program evolves, I'd like to hear a comment on that.

DE GROFF: The whole accreditation business is subject to considerable scrutiny. This is a personal observation. Whether I am correct or not, it's my observation that this is a question of establishment of minimum standards, more than anything else. It refers, in general, only to undergraduate curricula. Technology innovation, on the other hand, must be deeply involved in the research and development activities going on in the university; and therefore, deeply tied in with the graduate activities. I'm not suggesting that the accreditation people don't look at the research budgets and the research activities. They do. I have difficulty envisioning that our industrial colleagues, if brought deeply into that process--would generate pressure to do the innovative and the technology transfer jobs better.

COMMENT: One thing they might do, is reduce the emphasis on science orientated curriculum, and bring them a little more balance of economics--marketing, all other aspects.

DE GROFF: My first impression is that it's going "around the maypole" to get at the problem. There must be more direct ways.

QUESTION: As long as the federal government does most of it's research "out of house," with a much larger budget than industry, you're going to have this problem. The federal government is going to bid for more of the attention of faculty and students in the engineering schools. I think there are three ways that this problem can be alleviated. One has been mentioned; the use of faculty as consultants. This is usually a lot cheaper than supporting research programs. Secondly, the formation by industry or by companies, of effectual advisory committees to review their research programs, market planning programs, product planning programs; using faculty members on those advisory committees. Third, at a little higher level, is the use of selected faculty members on boards of directors; particularly in smaller corporations. These three mechanisms are relatively inexpensive from industry's standpoint. They capitalize on the knowledge that the faculty has gained in government programs and provide the mechanism for face-to-face human transfer. Do these stimulate any response from any of the panelists?

DUFFIE: Well, the notion of faculty participation on the board of directors of small companies is an intriguing one. I speak from zero experience at this, but if you've got a company that's not particularly research orientated, or not particularly orientated to the university, they probably have some built-in mistrust of professors in the first place. We again come back to the problem of getting together with the people in industry that have the common problems with the people on the campus. If you can do that, these mechanisms that you suggest are all appropriate. But we feel that we've got to go out and ring some doorbells. There's no substitute for it.

Professor Wilson commented on the handbook of the engineering profession. There are over two thousand technical journals published in the United States. I understand that the largest technically orientated company in the world, has established a policy: If the solution to the problem costs less than one hundred thousand dollars, they re-invent the wheel. In their experience, it costs over one hundred thousand dollars to go ask somebody to look through two thousand technical journals, or investigate the problem with an engineering faculty.

We find ourselves in the midst of exponential growth in all kinds of information; not only technological information. The problem is not a problem with engineering schools per se. Even though the economists had their say yesterday, we're trying to resolve really economic matters. The reason that industrial firms do not come to knock down the doors of the engineering schools is simply a matter of economics. When the dollars are dangled, anybody will respond. We have to realize that our economy is motivated by profit incentives. And even the governmental operations have what we call return. The government, through MacNamara's systematic approach to management, has required that DOD programs have to specify exactly what their intentions are; what they hope to accomplish and what the return is.

Consequently, what we need to teach in schools, is to teach people how to learn. Most courses of value in current engineering education possess half-lives of ten years at the most. We talk about continuing education, research, consulting, etc. Our problem is that today has been washed down the drain; gone forever. We have to realize that the business we're in is the information and process business. If we can get a handle on the information processing business, then I think we will generate the answers to these problems.

MULLIS: John, you mentioned one hundred thousand dollars to search two thousand journals. This is very germane to the point that I made earlier about the ordering of the information. The only reason it costs that much is because you have an extremely inefficient file to search. We can take a computer and look at two hundred and thirty thousand reports in about forty minutes (that's just how fast it takes us pass the tape past a reading head) and that doesn't cost one hundred thousand dollars. This is exactly what I meant when I said that we need to concern ourselves with the ordering of the information for the most effective use of the community that's going to use it.

QUESTION: Consider an engineer on a corporation problem. He decides what he thinks he needs. He feels that so-and-so in a university might help him. Before he can go to the university, he has to get an approval of a boss. He gets to the university; he hits the wrong man by chance; and the wrong man at the university fails to pass him to the right man. Instead, seeing a chance for a project, he says, "Yes, we'll work on this, we'll organize it and get going on it." Well, you carry it a little bit further; you end it up, and you go back home and the boss says, "We could have done that." So you end up with a complete negative situation; merely because you happened to get the wrong man at the university.

Now, we have to admit it, we're all selfish to a certain degree. This man was capable of doing it at the university, but there was somebody else who had already done it. The real point is, when you go to the university, you always get a proposal back, and that proposal is not half as good as one you'd write yourself. What are you going to do about that?

DE GROFF: My first rejoinder is that I doubt if there's anybody at this table that would quarrel with anything you've just said. We are acutely aware of this. It's happened too many times. It's happened not only to your company, but to many companies. You've heard here of some of the efforts that are trying to focus a place where industry can come to the university and get a responsible rejoinder to what they're asking.

COMMENT: It almost always results in a project proposal. This is not what they're asking for.

DE GROFF: It has happened. We wouldn't quarrel with this. On the other hand, Jack Duffie can recite instances now at the University of Wisconsin under the present system, where people are either helped out-of-hand by people who know the answers; or they're even told that no such competence exists at the university.

DUFFIE: Our job is to get the industrial people into contact with the right people at the university. If you have the right people you suggest that they help the commercial laboratories. If we don't have the people you say so. We try to seek out the common interests between industrial people and our university people. If we don't find them, we don't pretend to be a cure-all.

WILSON: We've been increasingly trying to respond to industry requests with a consultant, rather than with a project. Many of the problems that industry comes with require only a little consulting help. They don't need to set up a big project. This is one reason why we've eased up and tried to facilitate the consulting by our faculty in the last few years. Responding to a simple question with a research proposal just isn't what's called for in many cases.

COMMENT: Let me give you an illustration. A few years ago, one of our divisions required test equipment for testing leakage of windows and walls under hurricane conditions, the University of Miami has it. Miami had it but nobody around in this whole central area knew it.

DE GROFF: Well, as we have said, the criticism is valid, but certainly the universities that I know anything about, are making every effort to get this situation changed.

QUESTION: How much action are you likely to get by pulling so hard on this information retrieval, dissemination lever? It's not clear to me that this is really where you're going to get results. Instead of figuring how you're going to go around pulling information--wherever that information might be generated; the universities might give some thought to the idea of motivating its students much more, to be much more compulsive professionally about what it is they're doing.

George Wilson put his finger on it beautifully yesterday, when he was talking about incentive. I may be talking at cross purposes with my own thesis here, but the fact is, while money is a very powerful force, it's not the only force by any means. What the universities should be doing is training their engineers to be more compulsive and less timid souls. And the thing that I've seen is that the vast majority of these guys are really very restrained, conservative, almost "fuddy-duddies."

DE GROFF: We're getting down to about five minutes. I'd like to make sure that everybody has a brief opportunity to speak.

QUESTION: Can we learn something by looking at schools of medicine? Yesterday, we heard about the problems of the schools of business administration; this morning, schools of engineering. The schools of medicine are a third professional group found in the university. Generally, we have the impression that the schools of medicine lead, are in the forefront, in the dissemination of medical knowledge. This may be erroneous, but this is my impression. Can we learn some lessons from the technology transfer of the schools of medicine that might be applicable in engineering and business administration? That's one question.

The other point, as an ex-faculty member in business administration, I have often been rebuffed in trying to work with business firms because of their proprietary interests. I wonder whether faculty in engineering or business administration should involve themselves in business research, if there are proprietary interests involved? Should we not confine ourselves to matters which are of the public interest? Perhaps, the solution there is for firms within an industry, through their trade association to sponsor the work. Perhaps the trade association is a useful vehicle for providing funds and for generating research on the part of the faculty. This would be a benefit to the entire industry.

DE GROFF: With respect to your question about the medical schools, on Friday afternoon, the role of the medical sciences is to be dealt with. I presume that these broad questions will come up there. I'm sure that there are as many opinions on the proprietary question in this room as there are people. I'll give you one example at Purdue where we think this is working pretty well. By this, I mean work in a proprietary way. The university has, in the School of Mechanical Engineering, an establishment called the Herrick Refrigeration and Climate Control Center. They are almost completely supported by private industry money. And about a third of their research and development activities is proprietary. In talking to those people, while there are problems and they guard their tongues pretty carefully about results; much of what they're doing is public domain. Now, I do not mean the specifics of their programs. But the experiences which they are gaining, some of the broad fundamental knowledge underlying these proprietary programs is certainly getting broader application. Most industry people, in this day and age, want a headstart more than they want to get a complete bind. I don't really see any contradiction in university people doing proprietary work, as long as both sides have a very clear understanding of the limitations involved.

QUESTION: Certainly they're not supported by the faculty?

DE GROFF: No, the Herrick projects are supported by industry. It's one of the few places where I can point at Purdue where this is actually going on.

Well, gentlemen, it's right on the button. I'm sure we could go on with many interesting comments right through lunch. I would like to personally thank you on behalf of the panel for your kind attention, and also your very worthwhile and useful contributions.

END OF SESSION

LUNCHEON

Chairman:
D. C. Danielson
General Manager
Moderncote, Inc.

Speaker:
H. E. Riley
National Science Foundation

OUR INVESTMENT IN RESEARCH AND DEVELOPMENT

By

H. E. Riley

There cannot be any dispute over the importance of technology utilization for economic growth. We are surrounded by evidence of the ingenuity with which man has adapted natural forces and objects to his uses. This facility at adaptation is perhaps the most important characteristic that distinguishes homo sapiens from his progenitor. Early man was probably startled when a bent sapling slapped him in the face. We can speculate that his experimentation with that curious phenomenon led to the bow and arrow, highly sophisticated weaponry in its time.

Organized efforts toward technological development, through government support, have occurred sporadically at least from almost the beginning of civilization. The Pharaohs no doubt sought technological improvements in the construction of pyramids--perhaps they offered incentive awards for innovations. Not until the 20th Century, however, has mankind, through governments, begun to develop massive, systematic and expensive programs of research and development, directed toward finding new principles and new ways of doing things.

We estimate that over $23 billion will be spent on research and development during 1967 by the Government, industry and educational institutions of the United States. This equals about 3 percent of our gross national product. Over half a million scientists and engineers will be employed in the R&D endeavor.

We are spending from 10 to 20 times as much on R&D as we did during the war years, 1941-45, and the volume is still increasing each year. This investment has produced many dividends in the form of technological innovations, some of which have profoundly affected our ways of life and may have even greater effects on our future.

But some have questioned why we seem to get so little in return for our investment--so little in benefits to the civilian economy. If we are spending about 10 times as much now as we were twenty years ago, why aren't we getting 10 times in return?

The answer to this question can take several forms. In the first place, we have no effective measure of the output of research by which we can calculate the return per dollar spent. Research is not a machine process. It is what its name implies, a search, which may be fruitless in many instances. On the other hand, there may be germinating in some laboratory today an idea, a chemical process or an insight into molecular structure which may revolutionize our future and fully justify every dollar being spent on research.

But there is another aspect of these global dollar magnitudes which we should examine, to bring our picture into focus. The expression, research and development, embraces a variety of activities and the relative magnitudes of these components may change widely from time to time. Research and development embraces three major types of activity: basic research, applied research, and development. Although we have some difficulty in defining the boundaries of these activities, and the statistical measures of their magnitudes are not as precise as we would like, they represent fundamentally different things, and the differences are important for our assessment of the technological impact of research and development.

These matters are of definite concern to the National Science Foundation because we are attempting to collect and analyze current and complete information on the volume of expenditures, the employment of scientific manpower, and other features of the Nation's scientific enterprise in all of its aspects. NSF is also keenly aware of the distinction between basic and applied research and between research and development. NSF's traditional role--true, a tradition of relatively brief duration, less than 20 years--has been to support basic research. We attempt to meet needs in this area which are recognized but not satisfied through other channels. Our primary constituency in this endeavor is the educational institutions of the country.

For our surveys of research and development in industry we define basic research as, "original investigations for the advancement of scientific knowledge that do not have specific commercial objectives, although such investigations may be in fields of present or potential interest to the reporting company."

We have distinguished basic from applied research with the explanation that, "In basic research the investigator is concerned primarily with gaining a fuller knowledge or understanding of the subject under study. In applied research the investigator is primarily interested in a practical use of the knowledge or understanding for the purpose of meeting a recognized need."

I have illustrated the stages of the R&D process by the development of the transistor radio. Basic research resulted in the discovery of the unusual properties of semi-conductors. Applied research evolved from this discovery the transistor which could be used to control the flow of current. The development stage occurred when the transistor was combined with other components to form the complete radio receiver. Further progress in the development stage led to the finished and tested prototype, ready to be reproduced in quantity. From that point on, the production stage began.

If we look at the three components of the R&D aggregate, we perceive a logical relationship between the type of activity and the potential for technological "fall-out." Basic research establishes fundamental principles which may be essential for many technological advances. The difficulty is that much basic research, carried on in the true spirit of scientific endeavor, may not find immediate technological application because no one directly involved is concerned with practical utilization of the results. We need better communication, a more systematic method of disseminating the results of basic research to those who might find applications.

In this nicely compartmentalized definitional structure I have described, applied research as the process of translating theory into practice. This is, of course, an over-simplification. In fact, applied and basic research overlap to a considerable extent, or are inter-mingled. Educational institutions are centers of basic research, but they also engage in applied research. Industry is the principal performer of applied research, but many industrial firms support basic research as well, within the terms of the definition we use. Moreover the applied research itself may result in by-products which have the attributes of basic research when adopted for other uses through technological transfer.

Then we have the third component--development. This stage involves the conversion of the ideas, processes, materials, etc., into a working model. Although the possibilities for innovation at this stage are limited, the process of development is not entirely devoid of prospects for technological transfer. The prototype demonstrates to the outside world the results of the previous basic and applied research. This may spark ideas for different applications. Moreover, development is an experimental process, in that it involves an effort to make a workable and practical model. If it doesn't work, the engineers go back to the drawing board and the bench.

Nevertheless, the technological potential of development is not proportional to the expenditures at this stage of the process. A dollar spent on basic or applied research has a vastly greater probability of yielding technological by-products than the dollar spent on development.

I have dwelt on these conceptual aspects of R&D because they are essential to an understanding of the technological potentials of the $23 billion in expenditures. The key element in the picture is the fact that about two-thirds of these funds will be spent for development. Let's look at these magnitudes more closely. I don't have a complete breakdown for 1967, but data for fiscal year 1966 will serve to illustrate my point.

On the basis of reports received from the performers, we estimate that in fiscal year 1966 somewhat over $22 billion were devoted to research and development. Only 15 percent of this total was for basic research, that is for the fundamental investigations into chemical, physical, biological and other phenomena, aimed primarily at the discovery of new laws or properties.

About 22 percent--slightly less than $5 billion--was devoted to applied research. In a certain sense, this total may be thought of as our investment in technological transfer--the translation of ideas gained through basic research into practical products or processes. In fact, of course, the process isn't that simple. Applied research also generates new principles and properties, most of which may be directly related to the problem at hand but some having no immediate application. It is for this reason that we find great difficulty in separating basic and applied research, especially in the studies of industrial research and development.

About two-thirds of the basic research is performed by universities, colleges and other nonprofit institutions. On the other hand, nearly 60 percent of the applied research is performed by industry. This is what we would expect. It seems to conform to the natural order of things.

And we are not surprised to find that industry is the major participant in the development phase. Over three-fourths of the total funds used by industry were for development work. To put it another way, about one-half of the total of slightly over $22 billion spent in 1966 went to industry for development. Furthermore, about 60 percent--$7 billion of the total spent by industry on development--was provided by the Federal Government.

The bulk of this huge Federal expenditure on development work represents outlays by three Federal agencies who are purchasers of heavy experimental or prototype equipment. These agencies are the Department of Defense, NASA and AEC. The pivotal role of these agencies in the growth of Federal research and development expenditures over the past quarter of a century is difficult to portray in exact quantitative terms because of inadequate records for the early years. But we can perceive some general relationships from various scattered estimates. The total U. S. expenditures for research and development in 1940 have been estimated at $345 million. The Federal Government accounted for about 21 percent of the total, and expenditures by the Department of Defense agencies, plus the National Advisory Committee for Aeronautics made up 38 percent of the Federal total. For 1945, the last year of World War II, we don't have a satisfactory estimate of the expenditures by the economy as a whole on R&D. The Federal Government spent $1,591 million in that year, as against only $74 million in 1940. In the 1945 Federal total the Department of Defense, with $513 million, NASA with $24 million and the Manhattan project with $859 million, accounted for 88 percent of the expenditures on R&D.

By 1960 total expenditures reached $13,620 million, of which $7,738 million or 57 percent was Federal. Of the Federal portion, expenditures by DOD, NASA, and AEC represented 91 percent, or 52 percent of the U. S. total.

Between 1960 and 1967 NASA expenditures on R&D increased over tenfold, from $401 million to $5,300 million according to our estimates. Of the U. S. total for 1967, estimated at about $23,000 million, 70 percent will come from the Federal Government. In turn, DOD, NASA, and AEC will contribute 85 percent of the Federal portion or about 60 percent of the total for the country.

These figures emphasize the point of my argument. Over $9 billion of the Federal obligations for R&D in 1966 were allocated to development work for two agencies, DOD and NASA. Expenditures for development represent largely the purchase of hardware, and the bulk of this hardware is for military and space programs, much of which is not the type of equipment which might have civilian applications.

I need only mention such items as the launch vehicles, spacecraft and instrumentation included in the NASA development expenditures; the reactors in the AEC program; the Army's Nike-X anti-missle defense system; the Navy's Poseidon; the Air Force's Minuteman missle and C-5A military transport, and many other similar projects for which development expenditures were made in 1966.

Our defense and space programs are of immense importance to the country and their justification does not depend on their technological potential for the civilian economy. At the same time, however, we can hope and expect that many important indirect benefits will be derived from the defense and space programs. The payoff will be in many forms, often quite unanticipated, and over a long period of time. This conference, and many others like it, will help to find the channels through which these technological gains can be hastened and multiplied.

SESSION NO. 5

URBAN ADMINISTRATION

Chairman:
Byrum Carter
Dean of the College of Arts & Sciences
Indiana University

Moderator:
Lyle C. Fitch
President
Institute of Public Administration

Panelists:
James Kelly
Senior Economist
International Business Machines, Inc.

William H. Kolberg
Secretary
Special White House Task Force

Ronald Black
Analytic Services Incorporated

Thomas Rogers
Director
Urban Technology and Research
Department of Housing and Urban Development

INTRODUCTION

Dr. Carter called the session to order and introduced the moderator, Dr. Lyle Fitch.

Dr. Fitch first commented on the need to talk in net figures rather than gross when analyzing national product from a growth aspect. This was related to the discussions in Session No. 1 of the conference. He then established the purpose of this session as that of considering the problems of getting technology more deeply into the business of improving the quality of urban life. He re-iterated Dr. Myers point that technological transfer is an incremental process, and bits of space related technology can be applied to urban problems. He said the potentialities which we think we can see are not being nearly exploited. Although technological progress does go on, it's not being exploited nearly fast enough or imaginatively enough. One of the reasons is that there's no institutional mechanism for getting technology into the urban business he said.

He pointed out that while engineers are fond of saying that technology can do almost anything it's called upon to do, they wait for the call, but the politicians and city officials don't seem to know how to make the call. He contrasted this to the ordinary civilian market process where goods are put in the store windows and people can see them and buy or not buy as they choose. There's no analogous process for important technological developments relevant to the urban scene. He referred specifically to such things as the problems of air, water and noise pollution, solid waste disposal, transportation, and lag in construction technology which leads us to build houses pretty much as we built them fifty years ago, even two thousand years ago. He included problems of urban ecology, and the fact that cities are great heat producing centers; a fact which makes cities unbearable in the summer time, which leads to riots.

Dr. Fitch cited speculations as to what the increasing urbanization in the Northeast may be doing to the climatic pattern of the Northeastern United States. This lack of knowledge suggests some need for research on these effects and the needs of additional technology in the open space. He suggested that the problem is not only that cities don't know how to ask the questions, they don't have money to finance research and development.

As a final comment, he suggested that a lot of this problem is going to be solved by getting large chunks of money into the picture; not only for hardware technology, but also for social technology. Despite the white backlash against the events of the last couple of weeks (reference to riots in Detroit, Michigan) the problems will not be solved until much more money is provided, a large proportion of which is going to have to come from the federal government he said.

THE ROLE OF COMPUTER TECHNOLOGY IN SOLVING URBAN PROBLEMS

by

James D. Kelly

INTRODUCTION

It is generally agreed that our cities are badly managed, are prone to horse and buggy methods of doing things, and are faced with problems of the utmost seriousness. Various cities have made efforts to improve matters, including the City of New York where I have had some direct experience, but the results so far have been very modest indeed. Since more and more cities are now looking to computers for help in solving their problems, it seems worthwhile considering some of the things that can, and cannot, be expected from their use.

For purposes of convenient discussion, I have divided the tasks on which cities can reasonably expect help from the computer into three categories:

1. Housekeeping. Included here are the usual accounting, payroll, tax billing and other such humdrum jobs which can be done so easily by computer.

2. Operations. This category is of greater interest. It contains those tasks that are done to keep a city going on a day-to-day basis, exclusive of those that are basically mechanical in nature and consequently allocated to the housekeeping category. Some interesting examples will be given momentarily.

3. Information, analysis and policy formation. This is the most interesting category of all. Unfortunately, it is also the one that contains the largest number of headaches.

Our three categories now established, the first primarily for purposes of indicating the computer uses that I am going to ignore, we can turn now to a more extended discussion of the other two. "Operations" type uses of computers will be taken up first since they constitute such a large part of the interesting current efforts being made to apply computers to the problems of local government. However, a major aim will be to clear the ground for a discussion of the third category which, despite the headaches involved, also offers the greatest potential for getting at the root problems of our cities.

OPERATIONS

The basic difference between this category and housekeeping is that it has a "real time" aspect. For example, computers are being brought to bear on the problem of stolen cars. When the policeman in his patrol car spots a suspected "hot" car, he radios in the license number and perhaps the description for transmission to a computer center, the computer searches its files, and returns a "yes" or "no" answer to the patrol car in a matter of minutes. This not only leads to the recovery of more stolen vehicles, but reduces the danger of the police work involved. It is understandable that a policeman is a good deal more cautious in stopping the driver of a car that he knows is stolen than he is in stopping one that he merely suspects is stolen.

This one example of an application of computers in police work implies by its nature that there are many more. The ability of the computer to provide quick access to information opens the door to an increasingly more effective police force. Feed a computer the description of a person, for example, and there is no technical reason why it couldn't produce the name of every man in town with a criminal record who matches it. This kind of capability on the part of computers is such a commonplace that it no longer excites anyone, a function of the fact that we have now become so sophisticated about the minor miracles that are involved.

Other city departments obviously can benefit from similar types of help from the computer, and efforts to provide it are becoming increasingly more widespread. The city and county of San Francisco has a social services information system to expedite the handling of welfare cases. The geographically dispersed welfare offices are able to tap the store of information in the central computer, using terminals in each office that are linked to the computer by telephone lines. Alameda County in California has a computerized "People Information System", containing information on its population and employees gathered from the files of several county departments, as well as a "Police Information Network". New York City is in process of establishing a computer based traffic control system, and has set up a system of devices to detect and report air pollution at various locations around the city. Sensors determine the composition of the air and feed the data into a central computer where it is analyzed. The goal is to both establish a day-to-day record of what is happening to New York's air, and to trigger action to control the level of pollution. There are, of course, many more examples of such "operations" uses of computers that could be cited, and a proliferation of them throughout the country is obviously just a matter of time--and money.

INFORMATION, ANALYSIS & POLICY FORMATION

These efforts to automate various "operations" activities in cities are leading gradually to the establishment of "data banks", such as the Alameda County "People Information System" just cited. They are coming into being as a side effect of the main purpose being pursued. At least two cities, however, New Haven, Connecticut, and Detroit, Michigan, have explicitly set out to create such data banks, trying to gather bodies of data together that will be generally as well as specifically useful. The New Haven effort is based upon the notion that such a fund of information already exists, but that it is scattered throughout the files of the different city departments. The goal is to gather it up and have it available in one place, in the computer. It would then be available, so-to-speak, at the push of a button, whereas now it is available only with a great deal of effort.

The city of Detroit's effort has had a somewhat different focus. Detroit has created a physical data bank covering such things as the condition of the city's residential, commercial and industrial buildings; property assessment figures; age characteristics of various structures, etc. These data are available from the computer for "planning areas" as small as 100 acres. Detroit has also created a social data bank covering such things as crime rates, welfare, births and deaths, school truancy, and so forth, available on a census tract basis. Unfortunately, it has found that some of the data it has fed into its data banks are of questionable quality, i.e., dirty data. It is now in the process of considering how to improve the data, and also how to subject the data to the kind of analysis that will make it most useful for understanding and solving the city's problems.

The creators of data banks such as these bear an important responsibility to prevent their misuse to interfere with the privacy of the individual. Planning for appropriate limitations upon the kinds of data put into the bank, and who is to have access to it, should be a main consideration of the earliest stages of development.

How can this goal of protecting privacy be achieved? One way is to put as much of the data as possible on a depersonalized, no-name basis, i.e. reduce it to sets of statistical information. Most of a city's planning and policy formation needs do not require personalized data, and taking away the names produces the desirable result of letting everyone get lost in the statistical crowd.

Some data, however, may have to be labeled. In that event, access to it can be limited through adoption of security techniques. An electronic password system can be used which will deny access to those who do not know it. Elaborations on the password technique can be set-up to allow access to certain types of data, but not to others. Other techniques for maintaining privacy are still in the planning stage. The important point, however, is that we must be determined to use them. Privacy can be protected, but only if we are determined to protect it.

The effort being made in New Haven and Detroit, and similar efforts being considered elsewhere, are obviously moves in an eminently sensible direction. They represent an effort to begin the creation of management information systems for city governments, something for which there is a crying need. Computer applications of the "operations" type are desirable for the greater efficiency they create, but they are not going to introduce the transformation that is needed in city government if the deep-rooted, serious problems are to be solved. That transformation can only come out of the institution of effective management information systems, and probably a reorganization in city government structure as a result.

At this juncture I would like to draw on my experience with the Economic Development Council of New York City, (a private, nonprofit organization of businessmen, formed to help the city solve its economic and social problems), and present a list of questions on the economy of New York City which are either unanswerable (which is true of most of them), only partially answerable, or answerable after so long a lag as to severely limit the usefulness of the answer. The purpose in doing so is to point up the paucity of available data.

1. What is the unemployment rate, by neighborhood, by race, by sex, by age? (Much more is known about the characteristics of the unemployed nationally than the characteristics of the New York City unemployed).

2. How are these various unemployment rates changing on a current basis?

3. What is happening to the school drop-out population? How many are unemployed, how many are no longer in the labor force?

4. What kinds of jobs did the unemployed hold prior to becoming unemployed, if any?

5. What is the structure of family income levels in different sections of the city, and how is it changing?

6. Where, and in what kinds of jobs, are the residents of each section of the city employed?

7. What industries in the city are showing an increase in jobs offered, by section of the city? What industries are showing a decrease?

8. How many new businesses are being established in the city, and where? How many businesses have moved in, how many out, by industry, by section of the city?

9. What is the vacancy rate in commercial and industrial structures, by section of the city?

10. How many vacant parcels zoned for industry exist in the city, and how many for commercial use? How many are only marginally useful (such as industrial land that is marshy, if not actually under water?).

11. What is the physical condition of each type of structure in the city (residential, commercial, industrial), by section of the city? What is happening to the number of residents per room in each section of the city?

12. How much of each of the city's taxes is being paid by each of the different industries in the city? On which industries is the total tax burden heaviest, on which lightest? How does this tax burden vary within each industry? (Are the bigger firms more burdened than the smaller, or vice versa?)

If reasonably accurate answers to these questions and others like them were available, New York City would be in a position to know itself in a fashion that today is only a dream. There are, of course, literally tons of data available in the files of the various city departments. But much of it is scattered, and the quality of significant portions of it is questionable. Furthermore, much of the data needed to answer the above questions simply do not exist in New York City, and if they exist for any city in the United States it must be quite a small one to have generated so little publicity concerning its blessed condition.

Somehow the resources have to be found to fill the data gap that exists in the cities, either by the cities themselves, the states, or the Federal Government. Practically all of the cities in the country are, of course, strapped for cash, and the institution of a widespread, expensive data collection system has to compete with crying needs in education, welfare, health, etc. Under the circumstances the collection of fuller, more accurate information is apt to look like a luxury which can be ill-afforded. Unfortunately, effective steps to solve the problems that generate much of the education-health-welfare-crime-poverty difficulties in the cities are dependent upon a flow of adequate information concerning what is going on, with detail by area of the city. Without such information we are forced to operate on what is largely a hit or miss basis. Programs get launched that are vague as to purpose, involving wasteful expenditure of time and money, because the true nature of the problem is all too frequently anything but clear.

One of the hopeful aspects of this situation is, of course, the steady cheapening that is occurring in data processing costs. If the problem of collecting the data can be solved, the cost of manipulating it would generally be no barrier to its effective use. Fifteen years ago the IBM 701 did 2,193 multiplications per second at cost of $1.38 for each 100,000 multiplications. Today an IBM System 360, Model 75 can do 375,000 multiplications per second, a multiple of 171 of the 1952 rate, at a cost of $.03 per 100,000 or a little over 2% of the earlier cost. These well-known facts on increasing computer speeds are misleading, of course, because there has only been a modest improvement in the speed at which data can be entered into the machine and the results gotten back out. Nevertheless, the total cost of data processing has been moving down at a substantial rate, and the rate of decline augurs well for those facing the need to do an increasing amount of data processing in the years ahead.

Before passing on to another subject I would like to note one of the important side effects of the computerization of city "operations" and "information" activities. Before an operation can be effectively computerized, an answer to the question, "Exactly what am I attempting to do?" is required. Consequently, the introduction of computers tends to force rational procedure upon the user. The programmer must explicitly set down every step that the machine is to take. In the process, at least after a period of time, the question usually arises, "Why are we taking this or that particular step?" The end result has been, in many businesses, a reorganization of the corporate structure, and a considerable shifting about of duties from department to department, including consolidations of operations traditionally carried on in separate departments. Some substantial part of the efficiencies realized through computerization are traceable not to the machine, but to this rationalizing process. The process also usually involves a considerable number of forced adjustments of people's roles and methods of doing work. Since the traditional city government structure could use a good shaking up, the spread of computer applications in cities is likely to have a highly salutory effect.

One final section is needed to conclude this paper. It concerns the supply of analytical talent available to city government. That supply is inadequate now, and is going to become increasingly inadequate in the future unless steps are taken to remedy the situation.

Let us again return to New York City as an example. New York instituted a City Administrator's Office as part of the office of the Mayor in 1952, to act as an analytical arm of the city government. In doing so, the city was following the advice of the Mayor's Committee on Management Survey which had been set-up to recommend ways to make the city government operate more efficiently and effectively. The City Administrator's Office is still in existence, and has many valuable functions, but it does not adequately meet the city's analytical needs, particularly on questions concerning the city's economy. Consequently, in a report issued just last year, the city's Temporary Commission on City Finances[1] urged that an office of the City Economic Advisor be created with an adequate staff. It also urged that this City Economic Advisor have no administrative duties, but devote his energies and those of his staff strictly to the task of advising the Mayor, the City Council, the Board of Estimate, and the various City departments on questions with an economic content, and to carrying on the research necessary for doing so. (The city does have a Department of Commerce, but its functions are mainly administrative rather than analytical).

New York City needs an office of the type just described, and the need has the same kind of urgency as the need for considerably improved city economic data. The expense budget of the City of New York is second in size only to the Federal budget. The city government, however, does not have a scaled down equivalent of the sort of staff support on economic matters that the Federal Government gets from the Council of Economic Advisors, the U. S. Department of Commerce, the Treasury, and the Federal Reserve Board. The problem is partially a budgetary one, but not wholly by any means. The city government does not seem convinced that it needs a source of strong technical expertise of the type under discussion. But it does need it, and other cities need it too. I would like to illustrate the point by relating just one incident.

The City of New York has been losing manufacturing jobs for many years. This loss is particularly unfortunate because most of the manufacturing jobs are blue collar jobs, and the city suffers from a deficiency in the number of such jobs. Its population has been virtually stagnant, but its Puerto Rican and Negro Community has been growing, and many of the newcomers have low levels of education and job skills. (It is true that the New York Times carries page after page of help wanted ads, but almost all of them are for white collar positions requiring skills that most Negroes and Puerto Ricans do not as yet have).

Given the outflow of manufacturers from the city, it might have seemed reasonable to assume that new factory construction was at a standstill. However, an investigation showed such an assumption did not jibe with the facts. In the six year period between 1959 and 1965, almost 1,000 new factories were erected, mainly in the Bronx, Queens and Brooklyn.[2] This new

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[1] Better Financing for New York City, Final Report of the Temporary Commission on City Finances, August 1966, p. 66.

[2] Most of these new factories are quite small, with 10,000 square feet of floor space or less. This is not surprising, however, New York may be the city of big business, but it is also a city of small manufacturers. Average employment per factory is less than 35. This small size is largely

construction occurred despite the fact that there seemed to be many valid economic reasons why most of the manufacturing activities in New York City should be declining. If an office of the City Economic Advisor had been in existence it seems reasonable to conclude that this factory new construction activity would have been noted sooner. Perhaps more important, such an office would be in a position to find out why the occupants of these new factories feel that New York offers them an advantageous location despite the oft cited drawbacks that the city suffers from as a manufacturing location. It is out of work of this sort, which would seek to establish factually and specifically what is going on in the different parts of a city's economy, that the basis is laid for an intelligent city policy on economic affairs.

More is needed than just additional facts, of course, although they represent a vital beginning point. A substantial body of factual information describing the economic functioning of our cities would lay the basis for developing, and testing, theories that might explain that functioning. If a city understands how its economy is developing and changing, it can grasp its opportunities more effectively, plan for changes in a more orderly and intelligent manner, and anticipate problems instead of reacting to them on a crisis basis. For lack of information, and the understanding that the blending of fact and theory can provide, most cities are run by the seat of somebody's pants. If our national effort to solve the problems of the cities is to contain more direction and less fumbling, the information and theory gap that lies behind the fumbling has got to be closed. The computer can help, but what is really needed is a reappraisal of the low level priority that is presently generally assigned to the data problems of the cities.

MR. KELLY'S COMMENTS ON DISCUSSION FOLLOWING PRESENTATION

The main points flowing from that discussion were as follows:

1. The problems faced by the cities are largely racial in character. In particular, the flow of Negroes from the South to the northern urban areas has created them.

2. Negro discontent, including expression in the form of riots, is traceable to the fact that the North has not turned out to be the promised land it appeared to be, and the further fact that the Negro has faced severe problems of adjustment in coming to the northern cities.

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attributable to the ase and efficiency with which such manufacturers can function in a city where there are so many possibilities of going outside the firm for needed supplies, services, or labor. Larger firms are in a position to stock more supplies, and have more specialists on the payroll, thereby cutting down on their dependence upon other firms. This is a large part of the explanation for the fact that New York City has relatively few large manufacturers, but an extraordinary number of small ones.

3. A lack of jobs for relatively unskilled people has been one of the main ingredients in the compounding of the problems of Negroes in the cities. (Puerto Rican migrants have encountered a similar difficulty, of course).

4. The nature of Negro life in the South, and the still-present effects of the slave era, generally have resulted in a weak family structure in the Negro community, with strong matriarchical elements. The problems encountered by Negroes in the North, particularly the scarcity of jobs for unskilled Negro men, has weakened the family structure further.

5. From this weakened family structure and low economic status has flowed many of the other problems faced by Negroes. In particular, it has created what has become known as the "welfare" problem.

6. The following table shows the composition of the changes that occurred in number of welfare recipients, by welfare program, between 1956 and 1966. It is worth noting, in particular, that the increase in number of recipients under the Aid for Dependent Children program is greater than the increase in recipients under all programs, and largely explains the rise in the welfare rolls over the period. The rise in Aid for Dependent Children recipients is largely due, in turn, to the growth of Negroes receiving such aid.

Change in Number of Public Assistance Recipients 1956-1966, By Program

	December 1956		December 1966		Increase or Decrease 1956-66	
Program	Number of Recipients (000)	% of Total	Number of Recipients (000)	% of Total	(000)	%
Old Age Assistance	2,499	42.6	2,073	25.7	-426	-17.
Aid for Dependent Children (AFDC)	2,270	38.7	4,666	57.8	+2,396	+105.
Aid to Permanently and Totally Disabled (APTD)	266	4.5	588	7.3	+322	+121.
Aid to the Blind	107	1.8	84	1.0	-23	-21.
General Assistance	731	12.4	663	8.2	-68	-9.
Total	5,873	100.0	8,074	100.0	+2,201	+37.

7. The lack of economic opportunity for Negroes, and the resulting crumbling of the Negro family structure, involves the danger that a permanently dependent class of citizens will be created where welfare is a way of life, and education and job holding are deemed to be not worth the effort.

SUMMARY OF REMARKS BY WILLIAM KOLBERG

Mr. Kolberg catagorized himself as a social planner who, in the light of the events of the last two weeks, found it necessary to speak with less confidence than he would have a short time previously about what the problems are in the cities; what we are doing about them; what we ought to do about them, and what we will do about them. He quoted James Wilson of Harvard: "problems of the cities today are synonomous with the problems of the Negro." The problems we see now are human problems experienced by the largest minority in our midst.

He pointed out that of the ten major cities there is a majority of Negroes in several. The vast majority of the elementary and secondary school pupils are Negro. By 1975, the majority of the ten largest cities would be populated by a majority of Negroes. Therefore, the unemployment problems or human problems in the cities are the problems of the Negroes in the metropolitan areas of this country. The majority of the Negroes in this country now live in the North, and the majority of the Negroes in the North exist in the twenty to fifty major cities.

He then considered prospective solutions which have been tried. The unemployment rate has been reduced to 3.8 per cent. Of the 1.8 million new jobs that were created last year, white teenagers and females filled eighty per cent. That means that as employers need new people, they attracted secondary wage earners into the labor market rather than the unemployed Negro male. Obviously, employers decided, on thoroughly economic grounds, and legitimate grounds, that the best risks to fill their manpower problems were the secondary wage earners, typically white. This identifies these as human problems, affecting specific individuals.

To push the economy even harder, still is not going to pull these people into the work force. They were pulled in during the last war when we had an unemployment rate of less than one per cent. If we're willing to accept inflation of somewhere between three and four per cent a year, we can get full employment. He suggested that the majority of the nation's voters has kept saying through it's elected representatives, that it will not stand that kind of an inflation. He quoted from the President's most recent manpower message: "There are at least two million people in the United States, that will not be able to function properly in the labor market, without some manpower, specific manpower assistance." Mr. Kolberg said assistance means a better basic education, remedial education, or skill retraining, or motivational training, or all of the many other things that go into making a productive employee.

He stated that somewhere between a million and a million and one-half of these people live in our largest cities. Two-thirds are Negroes, with a heavy proportion Negro males. In our worst slums, over ninety per cent of the inhabitants are minority groups, mostly Negroes, Puerto Ricans and Spanish-Americans. The unemployment rates in those slums are three, four and five times the national rates. The sub-employment rate or marginal employment rate runs as high as one-third of all the people that ought to be in the labor market.

He then considered the job situation. In a recent survey in seven cities, there were nine hundred thousand new jobs created in the suburbs of those seven cities, and fifty thousand created in the central city. Most of the fifty thousand were 'white collar' jobs, that the ghetto Negro could not qualify for even after training. Hence there is an increasing mis-match between where jobs are becoming available and where the 'hard-core' unemployed people are living. There is really no good way devised yet to pull these two things together as long as the walls continue to be as high as they are around the ghettos he said. These people can't afford their own transportation. Public transportation does not get at the problem.

One of the problems is that people are reacting against a dilemma to which they find no out. He suggested reading the book, The Metropolitan Enigma put out by the Chamber of Commerce Task Force on Economic Growth and Opportunity. He quoted as follows: "The fact is, that for the first time since the late nineteenth century, American cities are experiencing mass violence brought on as an expression of discontent and fury. "The fact that these masses are Negro seems somehow to have lessened the impact of the rioting. The events seem somehow more natural, more an understandable response to a racially prejudiced society, than evidence of any deep social imbalance. One wonders, for example, what might be the response within the business community, if instead of reporting Negro disturbances, the press were to inform the nation that the workers or the proletariat, in Detroit and Los Angeles had set fire to their quarter, and had been suppressed by the summoning of military force." He suggested that this is very disturbing because it's right. Somehow we have separated off the fact that this is a product of prejudice. They're Negroes, and therefore, it's a different sort of problem. It's the classic problem of the working classes, the deprived in the society, saying that they want a chance. Concerning what we have done about the problem, he suggested that clearly we haven't done enough and we haven't done it very effectively.

Mr. Kolberg then turned his attention to the Manpower Training Act and the many government poverty programs. The federal government working with city and state administrations has mounted a number of training and retraining programs to reach these people to give them the basic education and skilled training that they've been deprived of. Basically, these programs have been classroom-type training programs. He suggested that this is probably one of the biggest things that's wrong. First, the public institution is typically slow and bureaucratic, especially if you have to move from federal through the state into the city. The ensuing frustration in slowness results in very little product. Second, the typically 'hard-core' guy (defined as probably a minority group member, may not have had very much education at all, if so in poor slum or southern schools, may have dropped out, experience with existing institutions has been very poor, finally, additional class room help, postpones him again, and doesn't seem relevant) is not going to sit in the classroom again. He needs money, and he needs money now. What's been done so far is not big enough for this problem. There are at least two million of these people.

We're producing a tremendous flow into this reservoir by the miserable slum schools he said. To fully attack this problem, requires all the resources, public and private, that can be mustered. The use of the typical public agencies will not be enough. This lead him to the main theme of his remarks, a proposal for a combination of industry and the public--public agencies--to work on the problem. Eighty-five per cent of the jobs in this country still remain in the private sector. Most training in this country is done on the job. The specific training related to the task that needs to be performed is provided by industry. Some of the basic education is provided by public agencies, but industry is the educator for work-skills. Consequently, industry appears to be one of the major educational institutions that somehow we have overlooked. Here lies the resources that have not been tapped at all, in terms of trying to train or retrain the people at the bottom of the economic ladder he said.

Mr. Kolberg asked the question: Why hasn't industry become involved in the problem? First, they haven't understood it and haven't felt a commitment, but perhaps because these people aren't good economic risks. It's going to cost a company money in order to put them on the payroll and the drop-out rate is going to be very high. Secondly, the Federal government spends between seven and ten thousand dollars a year per Job Corps trainee. Industry with say five thousand dollars a year per man could train and retrain, create jobs, and work men into their on-going, regular payroll. Why then shouldn't it be made profitable for a business to train these people ultimately, hopefully, putting them on the payroll?

Mr. Kolberg then took up the question of wage subsidies. He suggested reasons for avoiding them include worry about windfalls to business, administrative problems, and upsetting the market place by subsidizing one firm as against another firm. Perhaps the problem has become bad and big enough that these things can be now overlooked. Serious consideration should be given to a combination public-private program. Possible new programs that might be tried were cited as follows: Let development-type contracts to industry to develop new ways to train and employ the 'hard-core'. Specific objectives might be: How to restructure jobs? How to provide the basic education and skill training? How does one handle the seniority problems? Invent new ways to develop human potential and use it. The best minds in the private sector have not been put to this task. Perhaps they could make significant contributions.

He stated that the public sector is just beginning to understand the need for and the use of 'sub-professionals' the assistant teacher in the education system, the health workers, the sub-professionals who visit their friends and neighbors in the poverty programs. A lot more can be done along this line. Finally, he suggested a G. I. Bill concept for the people who have essentially been left out of our economic life. For instance, a person has been unemployed for six months out of the last year. He is the head of a family. He could be given a right of access to certain job training benefits and/or certain wage subsidy benefits, until he became a productive worker in a company. Typically, wage subsidies get thought of in the sense of what the employer gets out of them, but when tied to a specific individual where a decision has been made that this is probably the only way that he's going to make it, the reaction should be different. That's a decision on the part of society to make an investment which may have a high payoff. Cost benefit analysis of the G. I. Bill indicates that this is one of the most productive investments of fifteen to twenty billion dollars that the United States has ever made. The work done on the vocational rehabilitation cases suggests the same thing. Recent work done under the Manpower and Training Act seems to show the same potential.

Mr. Kolberg concluded that a number of the people who are now rioting and burning and pillaging are going to need a second chance in order to make it in our society. We need to begin to create that second chance.

SUMMARY OF REMARKS BY RONALD BLACK

Dr. Black commented on the increasing interest in the use of technology to assist in alleviating many urban problems. Yet very few successful examples are evident. One example is the new San Francisco Bay Area Rapid Transit (BART), on which his remarks were focused.

Two things were needed before technology could really be considered; first a focus for the various rapid transit interests in the Bay Area; and second, an organization which could carry out the innovation. Neither of these existed prior to World War II. During the War, it became obvious the transit facilities in the Bay Area were inadequate. Immediately after the War, the U. S. House of Representatives passed a Resolution asking the Army and Navy to set up a Board to investigate transportation in the Bay Area.

This Board, which was established in 1946, essentially served as the focus around which various persons and groups which had been interested in a rapid transit system could come together. One of the two major recommendations of the Board was that a rapid transit system should be constructed in the Bay Area. As a result of this momentum the California State Legislature in 1949, passed an Act called the San Francisco Bay Area Transit District Act. It authorized nine Bay Area counties to come together to form a district to construct a rapid transit system. This Act was not mechanically workable and in 1951, the Legislature amended it and created a San Francisco Bay Area Rapid Transit Commission. Their commission was to study the needs of rapid transit in the Bay Area and report back to the Legislature, which they did in 1953. The commission recommended a three quarters of a million dollar preliminary study of a transit system for the Bay Area. The state provided four hundred thousand dollars of this and the nine counties provided the additonal three hundred and fifty thousand dollars.

In 1957, the preliminary plan was completed with the Commission recommending that a rapid transit district be formed. The original district was composed of five counties, San Mateo, Santa Clara, Marin, Alameda and Contra Costa. One of the most important aspects of both the Commissions' activities and the districts' activities, for the next several years, was a public information program. Without this program, there is no doubt there would have been no innovation of any sort in the Bay Area. The major problem was to get a broad enough consensus in the Bay Area to pass the largest local bond issue that had ever been passed in the history of the United States, seven hundred and ninety-two million dollars.

The success of the program centered around how well two issues which arose during this time were treated he said. One was solving the issue of the transportation problem by construction of new freeways and highways versus construction of a rapid transit system. The second issue was that of central city viability versus suburban development. The latter gave the district the most trouble. In San Mateo County, a number of large property owners, reportedly, financed rather liberally a campaign against rapid transit. In late 1961, San Mateo County withdrew from the district. The remaining four counties didn't have a sufficient tax base to run the train across the Golden Gate and into Marin County. Marin County withdrew, although they did so reluctantly. The remaining three counties, San Francisco, Alameda and Contra Costa passed the bond issue in 1962.

The process of innovation was moving forward for sixteen years during which there was very little consideration given to technology. The commissioners had a philosophy that something better was going to be needed if they were going to pull the Californians out of their automobiles. Directors spoke, particularly in the early days, of rather futuristic systems; things such as rocket propelled trains and monorails and atomic powered trains. However, the engineering consultants were much more interested in sub-system, evolutionary innovations, rather than in a radical new transit system. As the engineers placed quantitative requirements on the system they were beyond what could be achieved "off-the-shelf". It was thought that the market provided by BART would not be sufficient to encourage equipment suppliers to develop and supply them. This was based primarily on what Cleveland experienced in the early 1950's. Consequently, the engineers searched for a mechanism to encourage equipment suppliers. The Chief Engineer for the district proposed that a development and test program be established to solve the problems of the BART system. It would be administered by an Institute of Rapid Transit and financed primarily by the federal government. All the operating transit systems and their equipment suppliers would participate. Nothing ever came of this.

Consequently, the plan which was presented to the Voters in 1962 included around three to four million dollars for development and test purposes. The way this money was included in the plan may illustrate how difficult it is to innovate on the local level he said. Development and test programs, would be criticized as subsidizing the equipment supply industry. Hence this money was called preoperating expenses.

After the election and the successful passage of the bond issue, four tax payers brought a suit against the district; and for about six months, virtually halted all work on the system. During this period, the engineers established a more formal contact with the Housing and Home Finance Agency (HHFA). It was agreed that HHFA would assist BART in a test and development program, if after the tax suit was settled, BART would propose a nine plus million dollar program, of which HHFA would finance two-thirds. This was the mechanism with which the district succeeded in getting the equipment suppliers involved.

Old-line equipment suppliers and many companies new to the equipment supply industry, some of them new to the sub-system areas for which they obtained contracts, entered bids. Many of them spent, up to two times the contract amount which they received, of their own funds in the development-test program.

Of specific interest was the way the district used engineering consultants as its technical arm. It was believed that it would be very difficult to get top-flight technical people for a one shot effort he said. Therefore, an architectural engineering firm which already had this talent assembled was engaged to serve as the technical arm. They occupied the same building as the district, and became almost indistinguishable from district employees. It took on a characteristic very similar to that which exists between the Air Force and some of its special non-profit corporations.

Dr. Black concluded that without considerable federal support for large scale uses of technology in urban areas, perhaps 10 times what San Francisco received, the process of innovation is going to cover a very long time span. In the San Francisco case, it covered something like twenty-three to twenty-five years. Technological innovations will be very limited, if they have to be supported primarily on the local level, because it's very difficult to amortize research and development funds, when you only have one system on which to amortize them. Since the federal government has a broader base from which to draw its funds, there can be more than one system on which to amortize the cost.

COMMENT BY FITCH: I think the BART system has interested us all, for reasons which Ron mentioned. Not the least of which was the 'gutsy' reaction of the people of the area in voting by at least sixty per cent plus. They had to have at least sixty to bond themselves for nearly a billion dollars to pay the capital cost of the system. Secondly, the support given the project by the business people in downtown San Francisco was a very important element. And they had their own reasons. They just thought the transit system would continue development of downtown San Francisco. People out in San Mateo County thought the same thing, and they were 'agin' it. And finally, one should note that a number of transportation experts, including the people of the Transportation Center at the University of California at Berkley, were against the BART plan.

SUMMARY OF REMARKS BY THOMAS ROGERS

Mr. Rogers labeled his remarks as personal observations relative to technological transfer into urban problem areas. Concerning federal support for research and development, he commented that it's not easy to get even if you've done something. This comment was related to the problems of congressional committee inquiries. He suggested that the Department of Housing and Urban Development has a long way to go before achieving a posture like a MacNamara or a Webb. Even these men do not get money easily. Federal support for research and development activities in one area of interest may be influenced by what other areas it can be taken away from.

Referring to injections of technology, more specifically finished products, he pointed out that they result from a great deal of engineering; from the passing of many notions through filters called development. It was his view that very little of the technology; the finished product; if it be sophisticated at all, is transferred promptly or inexpensively into the solution of problems for which it was not designed.

This position was defended with the following example. There used to be meetings held every two or three months dealing with whether or not two giant agencies, each investing enormous sums in a different rocket, could get together, decide on one rocket, and save money. Many people worked very hard trying to get together. Each agency had a problem and a solution to the problem. The problems seemed similar, and the solutions seemed similar. Those two agencies today both have their own rocket addressed to their own problem. The reason for this is, that although the problems were similar, and to a scientist almost identical, to an engineer they were quite different.

Another example was cited. There was a notion that two organizations ought to build a joint satellite-communications system to serve both civil and military needs. In each case, satellites are orbited by rockets. In each case voice communications was the objective. But they differed in concern about cost, law, regulations, and ultimate objective, hence no joint system.

He then turned his remarks to observations about the problems of trying to couple R & D activities at the federal level into urban problem areas. The first problem is ignorance, not stupidity, but ignorance he said. There are a great many men in the Congress, who have not had the experience; and therefore do not understand the impact which this country's research and development community can have on any problem, however large or however complex. This statement was not meant as criticizing Congress. It was used, he said, to emphasize the need to educate at the Federal as well as local and state levels.

The next observation concerned 'soft' scientists and 'hard' scientists and the need to establish effective communication between them. He then commented on the very small number of "first-class intellects" addressing themselves to the problems of life in the cities. This emphasized the need for his office to stimulate the intellectual engineering and scientific community to do this as citizens.

Finally, concerning Housing and Urban Development, he suggested that it's easier to focus on Housing than it is to focus on Urban Development, because everybody knows about hammers and nails. The concern with the housing business is how, without sacrificing the quality of housing, to drive its cost down. This is corrolary to raising the income of the poorer people so that they can afford housing. He stated in closing that these were the immediate impressions of a 'sometimes scientist', who's 'cut the umbilical' with the past, and who is trying to understand what technology can do and should do in the area of urban development.

DISCUSSION

QUESTION: An indistinctly recorded question was addressed to Mr. Kolberg concerning the information required to attack the problems of cities.

KELLY: The point I was trying to make in my presentation was that we need a much larger body of information concerning what is going on in the cities. Your point about the Job Corps is in line with this. Let me give you an example. We don't have enough information--statistical and otherwise--to really understand the true nature of a lot of the problems we are trying to struggle with in the cities.

Let's take school drop-outs. People that I've talked with say that they spot the ones who are going to drop out, down around the second or third grade. The kids get into the school system, and practically by the time they start kindergarten, they're behind everybody else. They fall even further behind. They learn to hate school every step of the way. On the Job Corps, they had a lot of problems. They tended to pull in the most trainable people. The people who offer the most hope. But it didn't do very much about the people just described who are really at the bottom, who have a complete disinterest in school. The very sight of a classroom practically nauseates them.

We need to collect a very much larger body of information about what goes on in our cities, so that we have a much deeper understanding. I have a considerable faith in research. When you get a large body of information and start thinking about it, and start 'stewing' about it, you begin to get a real feeling for what the nature of the problems are. I think the information we have on what goes on in our cities just doesn't allow us to have this kind of real feeling. It's a 'hit-or-miss' surface kind of a thing. This is a large part of the problem that we are having.

KOLBERG: I doubt if anyone in the country really knows what the answers are, or even what the problems are in Detroit. I'd offer a couple of comments though. If you look at the social statistics we do have, and compare a city like Detroit with a city like New Orleans, or San Antonio, or Birmingham; you would say on the face of it, considering the extent of the problem, that those three cities should 'blow' a lot sooner. The people are a lot worse off. Now why don't they? The answer must be that the people in those three cities--typically southern--are not far enough up the ladder yet to have developed leadership, to have expectations.

You go to those cities, and you don't find any ferment of any kind. The programs aren't being run there either. The people are a lot worse off. In my own judgement, what this means is that we're going to have a period of civil disorder, in this country for five or ten years or more, no matter what we do; no matter how well the programs are run; no matter how large they are. This thing has been building for four hundred years. And we are kidding ourselves if we think there is any quick fix. We're going to have to pay the price. I hope that we don't find the price so high that we're unwilling to pay it; that we'd rather pay it by beefing up the oppressive forces of police, rather than go at what seems to me to be the basic problems, the human problems that keep showing up.

ROGERS: May I add one thing to that? Two groups of people can look at the same situation and draw diametrically opposite conclusions. The social scientist, the political scientists, behavioral scientists, anthropoligists are almost at their wits end over the tremendous demands that are being placed on them to 'tell us why.' When physicists look at the same situation, they ask what the causal relationships are. "Show us what happens when you push in here." They can't get any answer to questions like this. They say, "Well, it's so primative, we hardly know where to begin." I think one of our concerns, as scientists and technologists in general is to try to puzzle out how we can go about obtaining information of a causal nature. We certainly need much better statistical information, observational information, etc. But that to the physical scientists is only the beginning. Those are the things that light the light that get his attention. Then he wants to erect models, theories, hypotheses which he can test. This is something which a few social scientists discuss with me in the privacy of their own offices, but very seldom at large meetings.

QUESTION: Mr. Kolberg mentioned that he would like to see a greater involvement of the private sector in the Manpower Development Training. I wonder if he would have any comments on how a business man should get involved in dealing with these sub-margin people. After all, business produces most of the profits which makes it possible to sponsor federal programs. Do you have any news on the Human Investment Act? Have any other proposals been made that would give the business man some incentive to take this on?

KOLBERG: Apparently, I didn't make myself clear. For patriotic and other reasons, business can go some of the way, and many have. The jobs now programmed in Chicago, some of you may know about. Inland Steel took twenty-five of the toughest kids that you can imagine, and it worked with them. It was expensive. Realistically, we can only expect companies like Inland Steel to go about that far--twenty-five to fifty individuals, and they've got a work force of twenty-five thousand. After that, we've got to make it economically possible for business to do the job. This is the only way it can be done on company payrolls. As a minimum, we've got to make it possible so that business doesn't loose money. And it wouldn't bother me frankly, if we made it profitable; like what is being done in Job Corps camps. The businesses running Job Corps camps certainly aren't getting wealthy. Four to six per cent return, is probably less than they have in the rest of their operations of that size, but they certainly aren't losing money. They're devoting some of their better managerial talent to it. It seems to me that's what's got to happen.

QUESTION: Do you have any idea how this could be brought about? And I asked specifically about the Human Investment Act.

KOLBERG: My own personal feeling is I'd rather have it on top of the table, rather than through tax credits. I think we can look at it and see how large it is, and we can control it and administer it a whole lot better. You can see what kind of a product you're getting in return.

ROGERS: The last time I was in Viet Nam at Da Nang, there'd just been a crash on the air strip and men killed. The General was a little bit late getting in to lunch. When he came in he asked, "what are you doing?" "Well we were talking about some of the problems--" And he said, "Stop! Marines have no problems, Marines have opportunities."

When industry, in the housing business--particularly in the 'rehab' business, finds out there's money to make there it will change. When they start thinking, really thinking about how to tear buildings down or rehabilitate them and make money at it; then that part of it will be 'off the dime'. I don't think they should come to the federal government first. All they have to do is walk downtown and start thinking about it.

COMMENT: There is an angle on taxes, to which Mr. Kolberg referred, that might work a little differently. A businessman called me during this past week concerned with Detroit. He had analyzed our tax structure, the re-institution of the seven per cent credit, the guidelines accelerated depreciation, our tax structure particularly in realms where you may have an option on policy. He suggested that if you have relatively full employment and not too much pressure for war, our tax structure still works to keep those people unemployed. If we would begin to trade off, the consequences of the costs of riots and the impairment of GNP in a relatively full employment town against the lack of stimulus there to the GNP growing out of the investment credit; there may be a good payoff by just simplifying our tax structure. The tax structure now induces unemployment that leads to much of this disorder. He has some interest in the various tax credits for taking on these people, or, if you could work out the guidelines for capital equipment; you could work out guidelines for tax credits on the basis of capital to labor ratios just about as well. We might gripe about them, but they wouldn't be any worse than what we now have.

QUESTION: I have a question for Mr. Kolberg concerning his wage subsidy approach. An alternate has been suggested. It deals not with subsidies, but with investment. It asks the man who needs retraining and needs subsistance during retraining, to buy futures. It asks him, in fact, to make an investment, guaranteed perhaps by the federal government. It seems to me that this implies a psychology and an incentive that might be more rewarding than the subsidy approach. First; if it's his own money that he must, in part, repay, he perhaps is motivated more to be most efficiently and effectively retrained. To be retrained for that which he is really interested in when he is finished. It might also be more politically palatable. I'd like your reaction to this investment philosophy versus the subsidy approach.

KOLBERG: First off we're talking about two different kinds of people. The kind of people you're talking about are you and I. If the G. I. Bill had been structured on the basis of the federal government loaning you money to go to school and you'd repay it, I don't think it would have been nearly as large, but I still think it would have been an important large program. The kind of people we're talking about here, the really alienated, 'hard-core' guys that are essentially 'drop-outs' from society don't have any faith in any of our institutions. To ask them to have enough faith in order to get a loan and repay it isn't likely to seem credible to them.

QUESTION: If they lack this faith, then why would they be motivated by simply retraining them.

KOLBERG: This is a mortgage on their future. For some of them it may work. To make loans for future returns certainly is the way that most of us think about these sorts of things. I just have some doubts about whether it would be nearly as effective. If the reason you're going at the program is because of an investment in society; why don't we just write the investment off?

QUESTION: I'm thinking of the motivational aspect of it, rather than the return.

KOLBERG: I think that's kind of a 'middle-class' motivator. I have some doubts about it.

ROGERS: I'd like to make a comment on the motivation. It's tough enough to get a lot of these people to accept retraining in the first place. To ask them to mortgage the future as well, is just one more obstacle. If we thought it worthwhile investing in the G. I. Bill, which I think was an excellent idea then why not spend some of the public's money to invest in these people, most of whom are considerably needier than many of the people who went to school on the G. I. Bill.

END OF SESSION

SESSION NO. 6

RESEARCH ON TECHNOLOGY TRANSFER

Moderator:
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Panelists:
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RESEARCH IMPLICATIONS OF THE TECHNOLOGY TRANSFER PROCESS

by

David W. Cravens

STATE OF THE ART

The diffusion of new technology into various uses and avenues of application can be viewed as a natural process. Thus, when we speak of research relative to the process of technology transfer, we refer to the quest for a better understanding of this admittedly complex natural system.

The ultimate objective of seeking through research a better understanding of how the natural technology transfer process operates is to identify promising mechanisms and technology transfer channels which might be utilized in accelerating the flow of new technology to business firms and in particular to those not active in the natural diffusion system.

The question of whether or not the search for a better understanding of technology transfer processes is in itself a worthwhile goal, will not be considered here. Others have explored it in depth and the assumption is made that the quest for understanding is justified.[1]

The level of interest which has been generated in technology at the national level is suggested by the report on Policy Planning for Technology Transfer.[2] It is further indicated by the present degree of financial involvement on the part of the Federal government. Significant expenditures are being directed toward technology transfer programs.

It is appropriate at this point to consider the nature of our present body of knowledge concerning technology transfer. Perhaps most important is the fact that efforts directed toward the transfer of new technology apparently seem to yield results more rapidly and in excess of those that might be expected from the natural diffusion process. The programs and activities of the National Aeronautics and Space Administration's (NASA) Technology Utilization Division are indicative of these directed efforts. The NASA Regional Dissemination Centers (RDC) have specific missions to aid and accelerate the flow of new technology resulting from government R & D efforts to private industry.

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[1]See Richard L. Lesher and George J. Howick, Assessing Technology Transfer, NASA Sp-5067 (Washington, D. C.: National Aeronautics and Space Administration, 1966) for a careful assessment of the case for attempting to accelerate and diffuse on a more extensive basis the flow of new technology.

[2]Subcommittee on Science and Technology, Policy Planning for Technology Transfer, A Report to the Select Committee on Small Business, United States Senate (Washington: U. S. Government Printing Office, May 1, 1967.)

The question of the economics of these transfer efforts is by no means clear at this time. Measurement problems are difficult in terms of achieving cost-effectiveness comparisons. However, the information transfer mechanisms available from the RDC's involve quite modest costs to prospective users. Results gained from these transfer systems appear to be in excess of user costs.

The body of knowledge on technology transfer that has been assembled to date consists primarily of the recorded experiences of those who have carried out transfer activities. While these fragments of findings contribute to a better understanding, it is difficult, if not hazardous, to attempt to generalize from them.

A certain amount of pioneering and exploratory effort seems appropriate in attempting to understand and analyze complex, natural systems. I suggest that a stage of development has been reached in technology transfer such that two interrelated actions are indicated: (1) a careful assessment of findings to date, promising avenues identified, and the problems encountered specified, and (2) the formulation of a blueprint for future action.

The basic intent of this brief statement is to suggest the current need for pulling together our modest reservoir of technology transfer wisdom--and to order these findings against a framework which will be helpful in relating our findings as well as identifying questions and problems for future investigation.

LEVELS OF INTEREST

The questions relevant to understanding the technology transfer process would seem to be different depending on the level of investigation and the point of view taken: At least five levels can be identified:

1. The Public Policy or Aggregate Level. Here interest is centered in the entire system--the major elements involved and their interrelationships.

2. The Intermediary Level. This involves the level of interest reflected by the technology transfer intermediary such as the Regional Dissemination Center or the State Technical Services Act Agency.

3. The Industry Level. This level refers to common interests with respect to a group of firms making up a particular industry.

4. Institutional Level. Institutions such as universities and not-for-profit research institutes fit into this level.

5. The Level of the Business Firm. This level of interest centers on the individual firm.

By breaking down interest in technology transfer into these five levels, we have the beginning of an analytical framework of potential use in ordering our present state of knowledge and in leading us to the identification of relevant questions.

For example, questions of relevance at the public policy level would very likely be different from those of the industrial firm seeking to improve the inflow of externally generated technology. Likewise, the technology transfer intermediary might focus on a third set of relevant questions. We might begin to structure our base of knowledge by using the admittedly crude frame of reference shown below:

	Current State of Knowledge	Appropriate Activities	Questions for Investigation
1. Public Policy	X	X	X
2. Intermediary	X	X	X
3. Industry	X	X	X
4. Institutional	X	X	X
5. Business Firm	X	X	X

This relatively simple framework: (1) provides for the partitioning of our current state of knowledge into five sections; (2) suggests that each of the five levels might involve different activities (and capabilities); and (3) indicates a group of relevant questions could be generated for each level. Of course, an effort to partition such a complex system into mutually exclusive sub-elements must consider the nature of the interrelationships among the levels involved. A certain amount of overlap is inherent. The important point is that we have a structure which recognizes different points of view.

Certain of the cells are blank at present. This might, in itself, suggest future emphasis. Activities appropriate at one level may well be inappropriate at another. The framework helps to make these important distinctions.

SOME RELEVANT QUESTIONS

In conclusion, it might be useful to indicate the nature of the questions which seem relevant at different levels. Listed below are a few of the kinds of questions of interest at level 5, the Business Firm:

1. To what degree do business firms take an organized approach to setting up a network of external communications channels through which new technology can flow? What kinds of barriers exist?

2. Can a business firm organize internally to improve the inflow of externally generated technology?

3. Does the formulation, design, and implementation of intra-firm technology transfer mechanisms aid or hamper the process? If so, how?

4. Is the process of technology transfer so complex that organized mechanisms for accelerating the process tend to be less effective than the natural diffusion process?

5. Assuming that we can in fact improve the flow of externally generated technology into the firm, what are the major problems involved? Who should play the lead role in attempting to cope with the task?

In contrast, consider the nature of questions which seem relevant at Level 1, the Public Policy or aggregate level. Here are a few that immediately occur:

1. Which institutions should play lead roles in technology transfer policy questions and actions--business firms, government, industry groups, professional organizations, universities, etc.?

2. Who should bear the costs of directed technology transfer efforts? (Contrast here the NASA self-supporting RDC concept with the Department of Commerce, State Technical Service Act programs.)

3. What sort of public policy coordination of technology transfer program is appropriate at the national level?

4. To what degree is there a willingness and desire on the part of industrial firms to have the federal government actively pursue directed technology transfer efforts?

5. In what respects is the natural process of technology transfer deficient?

These are only a few of the many questions that might be hammered out at the various levels of interest. The questions indicated are, at best, only suggestive. The important point that hopefully has come out of this discussion is the need for pulling together our fragments of existing knowledge into a logical, yet flexible, frame of reference which would lead to: (1) identifying appropriate activities and capabilities at each level and (2) raising relevant questions for investigation at each level.

RAW MATERIALS FOR TECHNOLOGY TRANSFER

by

W. D. Snively, M.D.

Serendipity has been defined as the "happy accident;" the gift of finding valuable or agreeable things not sought for. It seems to me that in this business of technology transfer we are really carrying out planned serendipity; planned happy accidents. We expect them to happen. We don't know what they are going to be, but we look for them to happen. I am going to talk about the raw materials for technology transfer and give you some very specific examples. My view-point is medical and pharmaceutical; the end product that we are interested in--in the medical profession and in the pharmaceutical industry--is really better health. But better health has several sub-products such as better prevention of disease; better diagnosis; better treatment on the part of doctors; and better products by pharmaceutical companies.

I decided to examine, rather systematically, some of the events that happen to humans when they are subjected to three kinds of stress. First of all, time stress: the stress of very rapid movement by jet flight. Second, a space stress: the stresses that occur when one goes into outer space. Third: the stresses that happen to one when he goes into inner space, or into deep sea diving.

This presentation is designed to talk both about raw materials and technology transfer; but it also is a demonstration of what ARAC can do for member companies. Every bit of this material I am going to explore with you came from the computers at ARAC, which gave me almost, in real time, the basic materials for this discussion. So, let us take a look at the results of these three kinds of stress, and examine each one of them from the standpoint of what they may or may not offer in technology transfer potential. I think we have to recognize that here, as in any field of technology, these transfers don't happen automatically. We expect them to take time. We anticipate frequently that they will require money for development. As we go over these raw materials, I am going to mention various possibilities for technology transfer, some which have already happened. Others I am sure will happen in perhaps the not far-distant future.

First of all, when we fly in a jet airplane for over four hours, we become dislocated with respect to time. From jet flights we have learned that there are all sorts of body functions that follow a very regular sequence. These are regulated by a mechansim, some place in our brain, that is called the "biologic" clock. Those of you who have taken long jet flights know that you have felt very bad for one to four days after you get to your destination. This is because you are dislocated as to time.

Now, what physical modalities are modified by very, very rapid changes in time? The first of these is body temperature. Body temperature follows a very precise curve, reaching a peak about five o'clock. If you are dislocated in time for about four hours, it will reach a peak about four hours different from that. Our second modality that follows a set time schedule is the number of dividing cells in any dividing tissue. Here we have our first transfer, because this gives a clue to doctors that are treating cancer by a so-called profusion technique. This provides a guide as to the time of day most appropriate for the profusion technique. The next is urine volume. The urine volume reaches a peak at one time of the day, and a minimum at another time of the day. We know that we cannot judge the urine volume unless we get a 24 hour specimen. You know in space flight, the astronauts had to get rid of it, so they threw it out the windows. So, a new heavenly body was born. As far as I know, here there is no technology transfer involved.

Accuracy and calculation definitely follow a 24 hour pattern. There are certain times of the day when we are most accurate and certain times when we are least accurate. I would say that the time of least accuracy is about 1 or 2 hours before sun-up, when our alertness and our abilities to respond to stimuli reach a low ebb. The Indians were very well aware of this. As you read pioneer history you will see that they almost always attacked at just before dawn. This gives us a clue for space flight or any other time when you are dislocating your "biologic" clock. If you have to do some calculating in a period when your accuracy is going to be at a low ebb, then it's time for a stimulant drug like one of the Dexedrines.

Calcium excretion definitely shows remissity throughout the 24 hours. This teaches us that if we are going to find out how much calcium is coming out in the urine, we have to do a 24 hour specimen rather than just taking a sample once a day. The same holds for potassium. There are two peaks for potassium excretion, in the morning and in the afternoon. So we have to take a 24 hour specimen, if we want to know how much potassium is being excreted. Water excretion also shows a periodicity.

Proneness to error, very much as calculation, does show several peaks during the day. Almost all of these valleys and peaks are about the same in different individuals. When people are placed in soundproof rooms and they loose all sense of time, these peaks and valleys continue for a long, long time. Fever shows a real periodicity as well as a practical implication. If you have a patient that has just come over from France, and he has an infection then he is going to have a fever peak at a different time. He will be on Paris time for about four or five days. Brain waves also show a definite periodicity when they are tested by the electroencephelogram. This is useful, particularly if a patient just arrived from another area by jet flight.

Secretions from the adrenal glands show periodicity. For example, they are at about their maximum during the evening, which means that certain types of medication should be given at this time. Another physical change that shows periodicity is the menstrual cycle. Now, this does show about a monthly periodicity, so it does not really apply to our 24 hour "biologic" clock. But it is a "biologic" clock nonetheless, and studies have shown that the disease cyclic edema is closely related to the periodicity of the menstrual cycle. This has given us clues as to the cause of cyclic edema.

Another disease, cyclic agranulocytosis, shows periodicity. This is a disease in which the white blood cells get very low in number. From this periodicity, some clues as to the cause of the disease have been obtained. Recurring mouth ulcers show very definite periodicity. And so does recurrent joint swelling. There is one case in the literature that is rather interesting. It concerns the star soccer player on the Cambridge University team. He had a joint swelling that was so periodic that the university was able to schedule their games around his joint swelling.

The peptic ulcer is another thing that shows very definite periodicity. Again, a clue to the cause is obtained from this periodicity. The uptake of materials, both from normal and cancerous cells gives us some real clues as to when to administer very potent medications for the treatment of cancer and for the treatment of the various other types of disease. The male hormone in males shows 24 hour periodicity. I might say that it is at its maximum from about 8 to 12. Females also have a small amount of male hormone in them, and that does not show periodicity.

Human parasites, although they're completely hidden from sight and go around in our blood streams, show a very definite 24 hour periodicity. This can give a clue as to when drugs should be administered. Asthmatic attacks are also periodic, and have a certain period in the 24 hours when they are most likely to strike. The same holds for heart blood clots, or coronary thrombosis. The various drugs have periods during the day when they are maximal. One of these is diuretics, such as the thiazide diuretic, which activates the kidney. Another is insulin. Both of these periodic peaks and valleys give us clues for administering these medications.

I might say that the majority of these transfers have not yet been transferred. They have not appeared in the literature as yet. But, more and more, we are getting these transfers into the literature. It is rather interesting that just this week the Journal of the American Medical Association had a major article on space flight by Dr. Charles A. Berry, the physician for the Astronauts, who was here last year. These transfers are occurring all the time. No one of them is a great thing in itself, but in the totality, they really add up to quite a bit.

Where is the "biologic" clock located? From all sorts of evidence, it appears that it is located in the brain probably in the region of the lower part of the brain, the hypothalamus. This is located in the base of the brain, near a large cavity called the third ventricle. This has actually been proved out to some extent because when you destroy this area in animals, they lose their periodicity.

Let us take a look at some of the space flight effects of body fluid. One of the first and one of the most amazing effects that occurred was weight loss. This weight loss occurred even after an astronaut had been up only 24 hours! It was a rather formidable weight loss; about 5 percent of his weight or so. It took a little bit of figuring to find out just how this happened; but it is pretty well accepted now that this weight loss in space flight is a result of the loss of gravity. And without gravity you do not get the pooling of blood in the legs that normally occurrs. Therefore, you have more blood circulating through the kidneys; more blood for the kidneys to extract water from and more urine lost. So, this is the explanation of weight loss due to diuresis. And while there is not any direct transfer that I know of, this gives us just a little more understanding of human physiology.

I might say, that before the astronauts took their flights, a lot of people thought they were going to be terribly upset by this very rapid flight, knowing that how even jet flight bothers people here on earth. Well, what happened was nothing because the astronauts stayed on Cape Kennedy time. They stayed right on the same time as they left on. But there are some other rather interesting things that happened. There was a marked decrease in the need for sleep, because of the inactivity.

Now we come to some rather important technology transfers. There is a whole group of events that occurred that we are going to have to correct if astronauts are going to be up there for over a week. These include diminished muscle tone, decreased tolerance to exercise, decreased ability to stand up or decreased orthostatic tolerance, decrease in muscle strain, decrease in blood volume, increased calcium urinary excretion, and an important loss of calcium from the bones (known as osteoporosis). Every one of these effects is really rather bad. They are going to have to be counteracted. There are all sorts of ways that they can be counteracted, such as exercise.

Do you know how much it costs to send a pound of food up? $75,000 a pound! It is important that the food be as light as possible; of high caloric value; low residue and minimal gas formation; and for obvious reasons, protected against chemical and biological deterioration. These foods have to remain safe over long periods of time. They are amazingly good but they look kind of awful.

Each astronaut has his own color, and he can just lift up his lanyard and pull his food out and unwrap it. There is a little water gun that you squirt in and that reconstitutes it. Now, one of the facts that is very interesting to me is that in all probability, the bottleneck to prolonged space flight is going to be nutrition and getting rid of body wastes. It is not going to be engineering or "hardware." It is not even going to be physical conditioning. The medical problems have been pretty well solved, even for prolonged flights. It is going to be nutrition and getting rid of the wastes that are going to be of prime importance.

Let us take a brief look at some of the effects of inner space on body fluid. I don't know whether any of you read what Scott Carpenter, who is both an astronaut and an aquanaut, had to say about this deep sea business. He says that when you think about it, here we have an area of space that is within a thousand feet of us, instead of within hundreds of thousands of miles. And probably, the benefits to man from this unglamorous inner-space are going to be far greater than outer-space. There are a tremendous number of projects going on in the area of inner-space; and particularly, in putting men down at the 600 foot level on the continental shelf.

The first physiological change that occurs is a marked acid condition of the body fluid. At first it is very acid and then the body produces chemicals to combat it. You still have a high level of acid but it's compensated for. The second change is that the retention of carbon dioxide in the lungs is increased. I am talking incidentally about deep sea diving without equipment. The plasma calcium and the plasma phosphorus are both increased. There are two very important threats to life. They go up quite high. Then there is a slow-down and a redistribution of blood. Blood leaves the muscles and the periphary of the body and certain visceral organs with remarkably reduced circulation. The heart rate gets very slow, and the lactic acid in the muscles floods the blood after breathing starts, but not before.

These changes might not be of a great deal of interest to you until I tell you that these are precisely the same changes that occur in diving animals and diving mammals. In other words, our physiology is so capable and so competent at meeting all sorts of strange conditions, that we automatically go through much the same physiologic changes as porpoises and whales and seals, and also, newborn babies before birth. And from this, the technology transfer potential is a greater understanding of what happens to babies before birth. They go through these very same changes. The technology transfer here is that we will be better able to manage babies that are slow in being born.

These are just a few of the technology transfers--a few of the raw materials. I could have given you quite a few more because there really is a formidable number. I think as we go on and you hear about technology utilization and diffusion that perhaps these examples will be even more meaningful. From this tiny, little field, and I deliberately picked one narrow field, the physiologic changes in the human being in exposure to time and space stress are examples of fields that are ripe for the harvest.

ADOPTION AND DIFFUSION RESEARCH: A POTENTIAL TOOL FOR IMPROVING TECHNOLOGY TRANSFER

by

Gilbert A. Churchill and Urban B. Ozanne

During the past decade, government agencies, business firms, universities, and other institutions have begun to focus on the problem of technology transfer. This increased awareness of the need to improve technology transfer is closely associated with the "post-Sputnik" flood of government-sponsored research and development. For evidence of the growing interest, one only has to sample the expanding literature on the subject,[1] to skim the recent report on Policy Planning for Technology Transfer,[2] or to glance

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[1]For a ready reference to the extensive literature on technology transfer, see the annotated bibliography prepared for the Office of State Technical Services by the Clearinghouse for Federal Scientific and Technical Information: Technology Transfer and Innovation: A Guide to the Literature (August, 1966), PB-170-991, STS 104.

[2]Subcommittee on Science and Technology, Policy Planning for Technology Transfer, A Report to the Select Committee on Small Business, United States Senate (Washington: U. S. Government Printing Office, May 1, 1967).

at the record of Federal expenditures in support of technology transfer efforts. For that matter, our presence here today testifies to the vital nature of the technology transfer problem.

Research into the adoption and diffusion of innovations provides a comprehensive set of terms and a conceptual framework well-suited to the study of technology transfer. In fact, we view technology transfer as nothing more than a special case of diffusion of innovation which in turn is one means to social change. The individuals and agencies concerned with technology transfer (change agents) want to increase the transfer (diffusion) of available technology (innovations). Those engaged in the transfer of technology are involved in the management of social change. They are charged with the responsibility of integrating new materials, processes, and products into the cultural inventory of our society.[3]

Diffusion research comprises a substantial number of studies that trace the _process of diffusion_, the _process of adoption_, and the _patterns of influence_ in the spread of new products and practices in a wide variety of situations and environments. Researchers from several academic disciplines have examined the diffusion of horses among Indians,[4] the spread of new farm practices among farmers,[5] the acceptance of new drugs by doctors,[6] and the selection of a new store by retail customers.[7] Given that the targets of technology transfer efforts are industrial firms and that many of the products developed from transferred technology are suitable for industrial markets, research into the acceptance of new products and processes by industrial firms should provide particularly valuable insights into technology transfer problems. However, the diffusion of industrial innovations has been subjected to relatively little systematic investigation.

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[3]Charles W. King, "Adoption and Diffusion Research in Marketing: An Overview," in Raymond M. Haas (ed.), _Science, Technology, and Marketing_, Proceedings of the Fall Conference of the American Marketing Association, Bloomington, 1966, p. 665.

[4]Clark Wissler, _Man and Culture_ (New York: Crowell, 1923).

[5]See: Herbert F. Lionberger, _Adoption of New Ideas and Practices_ (Ames: The Iowa State University Press, 1960).

[6]Herbert Menzel and Elihu Katz, "Social Relations and Innovation in the Medical Profession: The Epidemiology of a New Drug," _Public Opinion Quarterly_, XIX (Winter, 1955-56), pp. 337-52.

[7]Robert F. Kelly, "The Diffusion Model as a Predictor of Ultimate Patronage Levels in New Retail Outlets," in Raymond M. Haas (ed.), _Science, Technology and Marketing_, Proceedings of the Fall Conference of the American Marketing Association, Bloomington, 1966, pp. 738-49.

The major purposes of the present paper are to review briefly the field of adoption and diffusion research and to indicate its relevance for technology transfer. Can diffusion research provide technology-transfer agents with the means for improving their programs? Concepts and models developed from diffusion research certainly should help. Individuals working in this area are aiming toward: (1) the development of the means to increase the probability of success of an innovation, (2) the generation of analytical models for predicting the probability of new product success early in the life cycle, and (3) methods designed to shorten the diffusion period, the time from new product introduction to maximum market penetration.[8]

The balance of this paper consists of four sections. The first section presents a brief survey of the major concepts in diffusion theory. The next section contains a more detailed examination of the limited number of studies in the industrial tradition of diffusion research. The third section develops a model of the industrial adoption process and indicates some implications of diffusion research for technology transfer. The final section describes the research design and research methods that have been developed for a pilot study of the adoption of an industrial product.

MAJOR CONCEPTS IN DIFFUSION THEORY

Diffusion theory is a conceptual framework constructed to explain and predict the way in which ideas and implements spread within and between social structures. In his well-known summary of diffusion research, Rogers describes diffusion as a process with four essential elements: "(1) the innovation, (2) its communication from one person to another, (3) in a social system, (4) over-time."[9] In a similar but somewhat more detailed definition, Katz, Levin, and Hamilton characterize the process of diffusion as "the (1) acceptance, (2) over time, (3) of some specific item--an idea or practice, (4) by individuals, groups, or other adopting units, linked (5) to specific channels of communication, (6) to a social structure, and (7) to a given system of values, or culture."[10] In both of these definitions, the authors emphasize that diffusion is not instantaneous but is a process that extends through time. For example, more than 14 years passed before the diffusion of hybrid seed corn was completed in Iowa, while more than 50 years were required for full acceptance of a new educational practice.[11] A practical objective of diffusion research is the development of communications techniques that reduce the time needed for widespread acceptance of an innovation.

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[8]King, *op. cit.*, p. 679.

[9]Everett M. Rogers, *Diffusion of Innovations* (New York: The Free Press, 1962), pp. 12-19.

[10]Elihu Katz, *et al.*, "Traditions of Research on the Diffusion of Innovation," *American Sociological Review*, XXVIII (April, 1963), pp. 237-52.

[11]Rogers, *op. cit.*, p. 2.

A crucial element of the diffusion process is the innovation, an idea, practice, or product viewed by the potential adopters as a departure from the conventional and customary. The emphasis is not on newness *per se*--the significant consideration is how the item is perceived by the group involved. The process of diffusion includes the spread of the innovation among adoption units *and* the transmission of information about the innovation. The channels or sources of information that people employ in reaching a decision to adopt or reject an innovation have received a great deal of research attention. Diffusion researchers have examined the relative influence of advertising media, technical publications, personal selling, and personal influence. A particularly interesting segment of diffusion research aims at discovering the most important information sources within the various stages of the adoption-decision process.[12]

Innovativeness--Adopter Categories

One of the most characteristic concepts in diffusion research is the notion innovativeness, the degree to which an adopting unit is earlier in accepting an innovation than other adopting units. All people do not accept a new product or practice at the same time. Instead, different people adopt at different points in time and may be classified into adopter categories by dividing the resulting time continuum into segments. In other words, "adopter categories are the classification of individuals within the social system on the basis of innovativeness."[13]

Diffusion researchers have devised several different systems of adopter classification. In the best known systems, the adopters of an innovation are divided into five categories.[14] The "innovators" are the first 2.5 per cent to accept an innovation. The "early adopters" are the next 13.5 per cent of the people to adopt a new product. The third category of adopters is the "early majority," the 34 per cent of the potential adopters who bring the total adoption to 50 per cent. The pace of adoption accelerates rapidly as this group begins to accept the innovation. The last two categories are the "late majority" and the "laggards." They represent, respectively, 34 per cent and the last 16 per cent of adopters.

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[12] For an elaboration of the notion of "stages in the adoption process" and the information sources associated with them, see the last part of the present section.

[13] Rogers, *op. cit.*, p. 148.

[14] Most diffusion researchers have found that the adopter distribution--graph of the proportion of adopters versus time--approaches a normal curve. Using the implications of this generalization, Rogers constructs his standard method of categorizing adopters employing the two parameters of the normal distribution, the mean and the standard deviation. Adopters who fall within one standard deviation above the mean are considered early majority; adopters who are between one and two standard deviations above the mean are designated early adopters; and so on. See Rogers, *op. cit.*, Chapter VI.

Researchers divide adopters into categories to facilitate comparisons. Typically, they compare socio-economic characteristics and decision-making behavior of the adopters. Innovators and early adopters tend to differ from later adopters in their age, education, occupation, social status, income, cosmopoliteness, and so forth.[15] Moreover, the first to adopt tend to make greater use of information sources, employ a wider variety of information sources, and engage in a more painstaking evaluation process.[16] One may characterize the innovative group as venturesome, while the later adopter groups are often referred to as deliberate, skeptical, or tradition-bound.

The Adoption Process

"The adoption process is the mental process through which an individual passes from first hearing about an innovation to final adoption."[17] The word "process" in the term "adoption process" refers to a set of related actions or events extending through time. Decision-making is a process--it is the process by which an assessment of the meaning and consequences of alternative lines of action is formed.[18] The adoption process is a particular kind of decision-making. The acceptance of a new product, idea, or method requires the making of a decision or a series of decisions. The adopting unit must decide to investigate the new product, to begin using it, and to cease using the product that the innovation replaces.[19]

To assist analysis, processes are often broken down into a series of stages with a different type of activity occurring during each stage. Rural sociologists have devised several different models of the adoption process. The various models have from three to seven stages. The number of stages is somewhat arbitrary and depends on the point of view of the researcher. The best known model of the adoption process has five stages:[20]

1. Awareness. At the awareness stage the adopting unit (or a member of it) is exposed to the new idea but lacks full information about it. Rogers suggests that "the primary function of the awareness stage is to initiate the sequence of later stages that lead to eventual adoption or rejection of the innovation."[21]

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[15] Cosmopoliteness is the extent to which an adopting unit's orientation is external to its social system. Wide travel and interest in world affaris are often employed as surrogates of this characteristic.

[16] Rogers, op. cit., Chap. VI.

[17] Ibid., p. 76.

[18] Ibid., p. 78.

[19] Ibid.

[20] See: North Central Rural Sociology Sub-Committee for the Study of Diffusion of Farm Practices, How Farm People Accept New Ideas (Ames: Iowa Agricultural Extension Service Report 15, 1955), pp. 3-6.

[21] Rogers, op. cit., p. 82.

2. Interest. At this stage, the adopting unit becomes curious about the innovation and seeks additional information about it. The interest stage mainly serves to increase the store of data about the new idea.

3. Evaluation. At the evaluation stage, the potential adopter weighs the advantages (returns) of the innovation against its costs. If the returns are perceived to outweigh the costs, the process will continue.

4. Trial. If the innovation is a repeat-purchase item or if it emboides the quality of "divisibility", the potential adopter employs it on a limited scale at the trial stage. He tries out the innovation in order to establish its usefulness in his particular situation. With indivisible products, the adopter may improvise a trial. For example, a potential purchaser of a new machine tool may bring material samples to the supplier's plant for a demonstration.

5. Adoption. At the adoption stage, the adopting unit decides to purchase and <u>use</u> the innovation. The main functions of this stage are consideration of the results of earlier stages and "the decision to ratify. . .use of the innovation."[22]

By viewing the adoption of an innovation as a process extending over time, the researcher is able to distinguish certain properties of the process. These "dimensions" of the adoption process might involve such aspects as its duration, the number of participants, the sources of information used by the participants, the pattern of authority among the participants, and the amount of interaction among the participants.

The literature usually discusses the duration dimension under the title of the "adoption period." The adoption period is the amount of time it takes for the adopting unit to proceed from awareness to final adoption. "The diffusion period required for an audience to reach complete adoption is, at least partly, a function of the length of the adoption period for individual adopters."[23] Thus, by reducing the time each adopting unit takes to accept the innovation, one can shorten the period required for the innovation to reach widespread acceptance. The change agent (the sponsoring firm) may be able to shorten the adoption period by developing a communications mix more nearly approximating the informational needs of potential adopters.

A number of studies seek to discover the function of information sources at the various stages in the adoption process.[24] The researchers

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[22] <u>Ibid</u>., p. 86.

[23] <u>Ibid</u>., p. 118.

[24] See: Eugene A. Wilkening, "Roles of the Communicating Agents in Technological Change in Agriculture," <u>Social Forces</u>, XXXIV (May, 1956), pp. 361-67.

attempt to determine which media works most effectively within each stage. Katz, Levin, and Hamilton note that:

> The importance of this work is that it makes even more salient one of the central themes of this decision-making tradition, which is that the channels are better viewed as complimentary rather than competitive. In other words, it has become clear...that different media are appropriate for different tasks.[25]

THE INDUSTRIAL DIFFUSION TRADITION

The industrial tradition of diffusion research is perhaps the least-well developed of the several diffusion traditions. In a recent review of the adoption and diffusion literature, Charles W. King concludes:

> Many of these [concepts] are generally applicable to the industrial product setting. Research from the other traditions relevant to industrial product adoption and diffusion, however, is extremely limited. Research by marketers is essentially nonexistent. The application of diffusion theory in industrial product acceptance is an unexplored field.[26]

Moreover, a recent survey of more than 700 diffusion studies identifies less than a dozen industrial diffusion studies.[27] These figures may underestimate the amount of industrial diffusion research, since a number of studies commissioned by private firms remain proprietory information in confidential files.

Despite the limited extent of the published findings on industrial diffusion, researchers from a wide range of disciplines are working in this tradition. Industrial economists, industrial engineers, and economic historians make up a majority of those studying the acceptance of new products and processes by industrial firms. As a result, "a strong economic orientation is evident throughout the industrial tradition, and the economics of innovation have probably been analyzed more thoroughly in the industrial tradition than in any other."[28]

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[25] Katz, _et al._, _op. cit._, p. 246.

[26] King, _op. cit._, p. 684.

[27] Everett M. Rogers and J. David Stanfield, "Adoption and Diffusion of New Products: Emerging Generalizations," a paper presented at the Symposium on Application of the Sciences in Marketing Management, Herman C. Krannert Graduate School of Industrial Administration, Purdue University, July 12-15, 1966.

[28] Rogers, _op. cit._, p. 43.

In an early paper on industrial diffusion, Danhof introduces a classification scheme that anticipates the adopter category model from rural sociology.[29] The author divides industrial firms into four adopter categories on the basis of their innovativeness.

1. Innovators--the first firms to accept a new item.

2. Initiators--the firms to accept the new item immediately after the innovators.

3. Fabians--the firms to accept the new item only after a substantial portion of other firms in the industry have adopted it.

4. Drones--the last firms to accept a new item.

Most of the studies in the industrial tradition concentrate on pinpointing firm characteristics associated with innovativeness.[30] In two separate studies, Carter and Williams attempt to determine the characteristics of "technically progressive" firms.[31] The authors rate each firm as to its technical progressiveness and then set out to discover the firm identity variables associated with technical progressiveness. Carter and Williams identify 24 such characteristics including:

1. "High quality of incoming communication" as evidenced by subscriptions to scientific publications and contact with universities and other research organizations.

2. "A readiness to look outside the firm" as suggested by the world travel of executives and by their interest in "best practice" anywhere in the world.

3. "A high rate of expansion" as measured by the growth of assets.

4. "Effective internal communication and coordination" as evidenced by the ability of members of different departments to work out joint problems.[32]

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[29]Clarence Danhof, "Observations on Entrepreneurship in Agriculture," in Harvard Research Center on Entrepreneurship History (ed.), _Change and the Entrepreneur_ (Cambridge: Harvard University Press, 1949).

[30]Rogers, _op. cit._, p. 44.

[31]C. F. Carter and B. R. Williams, _Industry and Technical Progress: Factors Governing the Speed of Application of Science_ (London: Oxford University Press, 1957); and C. F. Carter and B. R. Williams, "The Characteristics of Technically Progressive Firms," _Jounral of Industrial Economics_, VII (March, 1959), pp. 87-104.

[32]Carter and Williams (1959), _op. cit._, pp. 94-102.

Alister Sutherland in his analysis of the diffusion of an innovation in the British cotton-spinning industry, takes a similar approach.[33] In examining the performance of 16 cotton-spinning companies, the author finds that the companies adopting the innovation are in general more "aggressive" than those not adopting the innovation.

Enos, in his study of the diffusion of refining technology, also is concerned with the characteristics associated with innovativeness, particularly the characteristic of profitability.

> Since technological progress permits the attainment of economies of scale, the most progressive firms will be able to build and operate the largest plants and thereby attain the lowest unit costs...It is thus greatly to the refiner's advantage to take part in technological advances. A prosperous refiner is the innovator; an impoverished one is the laggard.[34]

Enos makes an interesting conceptual refinement to diffusion theory by dividing the diffusion of a new item into two phases. The "alpha" phase consists of the invention of the new item (in this case a refining process), its development in both laboratory and pilot plant, and its first commercial adoption. The "beta" phase takes place after the first commercial unit has been installed and involves the diffusion of a constantly improving (process) innovation.[35]

The most prolific researcher and perhaps the most significant contributor to the industrial diffusion tradition is Edwin Mansfield. In a series of papers appearing from 1961 to 1964, he examines the diffusion of several industrial innovations from a number of different perspectives. In his first major paper, Mansfield sets forth a mathematical model of the rate of "imitation;" he tests the model using data that shows how quickly firms in four industries accepted twelve different innovations.[36] The basic hypothesis underlying the model states that the probability that a firm will accept an innovation is: (1) an increasing function of the proportion of the firms already using it, (2) an increasing function of the innovation's profitability, and (3) a decreasing function of the magnitude of the investment required. In a later paper, Mansfield extends his imitation model to include the size of the firm as an explanatory variable. He concludes that "the length of time a firm waits before using a new technique tends to be inversely related to its size and the profitability of its investment in the innovation."[37] Mansfield also analyzes the effect of market structure

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[33]Alister Sutherland, "The Diffusion of an Innovation in Cotton-Spinning," Journal of Industrial Economics, VII (March, 1959), pp. 118-35.

[34]John L. Enos, "A Measure of the Rate of Technological Progress in the Petroleum Refining Industry," Journal of Industrial Economics, VI (June, 1958), pp. 194 and 197.

[35]*Ibid.*, p. 182.

[36]Edwin Mansfield, "Technological Change and the Rate of Imitation," Econometrica, XXIX (October, 1961), pp. 741-65.

[37]Edwin Mansfield, "The Speed of Response of Firms to New Techniques," Quarterly Journal of Economics, LXXVII (May, 1963), pp. 290-311.

and the firm's growth rate, profitability, age of president, liquidity, and profit trend on the speed of the firm's response to innovations.

Mansfield has advanced the conceptual framework of industrial diffusion theory by investigating the "intrafirm" rate of diffusion--"the rate at which a particular firm, once it has begun to use a new technique, proceeds to substitute it for older methods."[38] Mansfield argues that the model he developed to predict the rate of diffusion of an innovation among firms is adequate to explain the rate of diffusion within the firm. Such variables as profitability of the innovation, the firm's liquidity, and the age of its equipment when the firm begins to use the innovation serve as predictors of the duration of the intrafirm diffusion process.

A MODEL OF THE INDUSTRIAL ADOPTION PROCESS

As noted above, the outstanding characteristic of the industrial tradition of diffusion research is its economic orientation. The researchers in this tradition extensively examine the economics of innovation and the characteristics associated with innovative firms. However, the students of industrial diffusion ignore completely one major segment of diffusion research, the industrial adoption process. They fail to investigate the process by which decision makers in industrial firms decide to adopt a new technique or product. Yet, a thorough investigation of the industrial adoption process should produce more significant insights into the problem of technology transfer than the more conventional research into the diffusion of industrial innovations.

Rural sociologists furnish much more of the conceptual framework for an industrial adoption-process study than do researchers in the industrial tradition. In fact, the five-stage model of the agricultrual adoption process provides a framework for the development of a model of the industrial adoption process. Figure 1 presents a diagram of this Industrial Adoption Process Model.

The Industrial Adoption Process Model contains three primary elements: (1) antecedents, (2) process, and (3) results.[39] The antecedents include the adopting-firm's identity, the decision-group's identity, and the participants' perceptions of the situation. The firm's identity influences the adoption of new items; it is composed of such variables as: the firm's age, its research and development commitment, its rate of growth, its industrial environment, its economic constraints, and its profitability.

With the exception of those anthropological studies that focus on the acceptance of an innovation by a tribe or by some comparable social group, diffusion research takes the individual farmer, housewife, doctor, or consumer as the relevant adopting unit. The individual may be the appropriate unit of analysis in much of this research. However, there are instances--the

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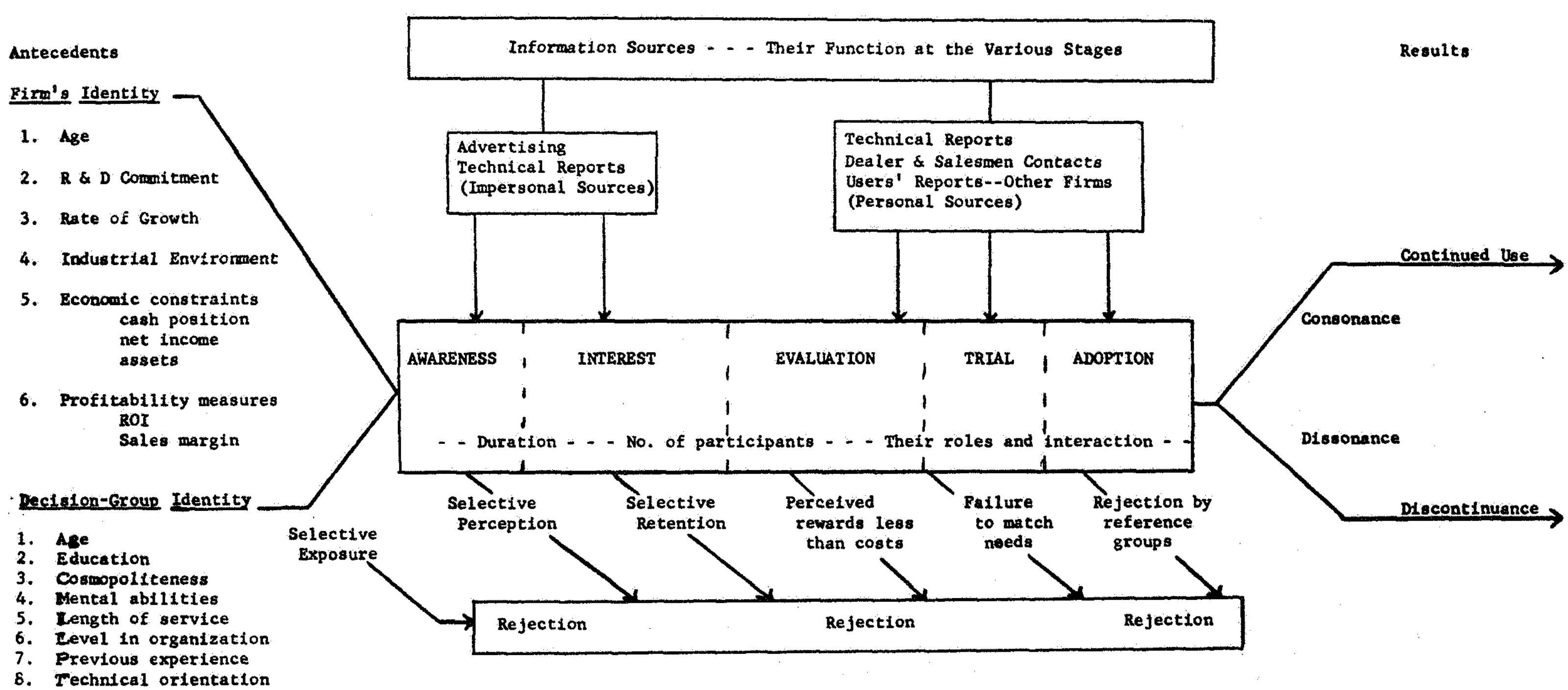
[38]Edwin Mansfield, "Intrafirm Rates of Diffusion of an Innovation," Review of Economics and Statistics, XLV (November, 1963), pp. 348-59.

[39]The present discussion relies heavily on the conceptual framework presented in Rogers, op. cit., pp. 305-07.

INDUSTRIAL ADOPTION PROCESS MODEL



Source: Adapted from Everett M. Rogers, Diffusion of Innovation, p. 306.

acceptance of an industrial product or process by a company purchasing group, for example--where focusing on a group as the unit of adoption produces more meaningful results.

Elihu Katz notes that:

> In thinking about the diffusion of innovation, one tends to overlook the obvious fact that not all innovations are adopted by, or intended to be adopted by, individuals. In the first place, different sorts of innovations may "require" different units of adoption...In the second place, different cultural or situational norms may "prescribe" different units of adoption for an innovation...Focusing only on the individual in such cases is misleading.[40]

The Industrial Adoption Process Model implicitly recognizes that a decison-making group is the most likely unit of adoption in the diffusion of industrial innovations. The characteristic of individual decision-group members are aggregated to form the decision-group identity variables.[41] Among these characteristics of the members (participants) are age, education, cosmopoliteness, mental ability, length of company service, level in the organizational hierarchy, previous experience, and technical orientation.

The perception of the situation held by each member of the decision-making group influences his adoption behavior. The norms of the member's social groups function as incentives or restraints on his actions. Individuals in a social system with a modern norm behave differently from those who are members of groups with traditional norms.[42]

The second major element of the model is the process itself. Information sources serve as effective stimuli to the decision-group members during the adoption process. At the arly stages in the adoption process, impersonal sources such as the mass media are the most important. At the later stages, personal influence and personal selling serve as the most important information sources.

Since the adoption of industrial innovations can be viewed as a process, one is able to measure dimensions of this process. The dimensions of the industrial adoption process closely parallel those of the individual adoption process and include such aspects as: its duration, the alternative solutions considered during the process, the number of decision-group members, the function performed and the degree of influence exerted by each member of the decision group, and the amount of interaction among decision-group members.

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[40]Elihu Katz, "Notes on the Unit of Adoption in Diffusion Research," Sociological Inquiry, XXXII (Winter, 1962), p. 3.

[41]Note that one conceptual difficulty here is the problem of aggregation. Not only is the group more (or something else) than the sum of its parts, but there is also the question of how to weigh each member's share in the resulting composite characteristic.

[42]Rogers, op. cit., p. 307.

The third and final element of the Industrial Adoption Process Model is the results. The process concludes in either adoption or rejection of the innovation. The firm may accept a new idea at the end of the process and may employ it continuously or the firm may reject the innovation at a later date--this delayed rejection is called a "discontinuance." The firm also may continuously reject the innovation.

We perceive two diffusion processes assoicated with the transfer of technology. The first diffusion process involves the transfer of the technique, implement, or material from a government agency or government-sponsored firm to a recipient-firm or firms. The second diffusion flows from the developer (the recipient-firm) out to potential industrial adopters (or to consumers.) For some technology, the success of the initial transfer may depend on the ability of the recipient-firm to market th developed products in the second diffusion process. A better understanding of the process by which individual firms adopt new products and processes should assist those who wish to speed or otherwise improve either of the two diffusion processes associated with technology transfer.

The Industrial Adoption Process Model provides a number of researchable questions, the answers to which could have significant implications for the improvement of technology transfer. Moreover, the model even suggests some of the possible answers to these questions. Let us briefly examine some of the questions raised by the Industrial Adoption Process Model.

The characteristics of the firm and of the decision-making group should account for variation in the dimensions of the industrial adoption process. Decision-making groups made up of cosmopolitan, well-educated, and technically-oriented members in profitable firms with rapid growth rates and good financial health may evidence a short adoption period and may employ a wide variety of information sources. If this were found to be the case, technology transfer agents would do well to direct their initial promotional efforts toward firms and decision-groups possessing these characteristics. Moreover, these agents of change should direct their communications to the fast-adopting firms through a wide variety of information channels.

The model implies that a portion of rejection behavior results from distortions in the participants' perception of the innovation and its applications. If this proves to be true, then the sponsoring firm must increase its efforts to educate potential adopters to the benefits of the innovation and to demonstrate the innovation's application in the potential adopter's situation.

The Industrial Adoption Process Model further suggests (as does the available research) that discontinuance is a significant problem in the diffusion of an innovation and that post-decision dissonance may be a major causative factor behind this behavior.[43] Given support for this

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[43]For a discussion of the problem of cognitive dissonance after the purchase of a product, see: James F. Engel, "The Psychological Consequences of a Major Purchase Decision," in William S. Decker (ed.), Emerging Concepts in Marketing, Proceedings of the Winter Conference of the American Marketing Association, St. Louis, 1962, pp. 462-73.

hypothesis, it behooves the technology change agent to spend more of his effort "selling" the innovation after its actual purchase.

A PILOT STUDY OF THE INDUSTRIAL ADOPTION PROCESS

As indicated in the preceding section, the Industrial Adoption Process Model suggests a number of different directions that can be pursued in the investigation of the adoption of an industrial innovation. The present section describes, in some detail, an adoption-process study we have recently undertaken. The study focuses on the adoption of a new piece of machinery by a group of industrial firms. It represents the first stage in a five to seven year research program on industrial marketing. This research program has its origin in our experiences in industrial marketing--experiences that highlighted the relative dearth of information available to companies marketing industrial products as compared to those marketing consumer goods. In particular, few process-oriented studies exist--studies that focus on the decision-making process in industrial purchasing rather than simply on the results of that process. This scarcity of process studies is in sharp contrast to the management discipline where a number of process-oriented decision-making studies have been completed.[44]

The product selected for the study is an automatic machine tool (hereafter referred to as the AMT) produced by an internationally known machine tool manufacturer (hereafter referred to as the XYZ Company). The AMT was chosen to focus the research because it represents a sizeable capital expenditure for most companies. The machine can cost anywhere from $35,000 to $70,000 depending on its size and on the accessories required. With this large an expenditure, one would expect to find that the purchase decision is not taken lightly. A group of decision makers are usually involved in an expenditure of this magnitude, and, moreover, the decision to purchase the AMT should entail a conscientious information search and a weighing of alternatives by the purchasing group. The AMT is not a radical departure from its predecessors, but its automatic control system and certain other features represent an incremental improvement. A deliberate attempt was made to locate a product like the AMT, because a large number of industrial buying decisions involve products with similar characteristics--an expenditure of sufficient size to require a group decision and a product whose newness does not represent a radical departure from existing alternatives.

The XYZ Company divides its AMT customers into six marketing divisions. Out of the total list of AMT customers, the population of interest includes all those customers in the two marketing divisions of the central United States.[45] From this geographical subpopulation, we constructed a probability

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[44]For an excellent review of the literature, see: Philip B. Applewhite, Organizational Behavior (Englewood Cliffs: Prentice-Hall, Inc., 1965), pp. 53-91.

[45]It was necessary to limit the study geographically in order to conserve research funds. All customers in the midwestern states of Minnesota, Iowa, Kansas, Missouri, Illinois, Wisconsin, Michigan, Indiana, Kentucky, Tennessee, and Ohio were included in the subpopulation.

sample of 70 AMT purchasers. The field research employs personal interviews to secure the basic data of the study. We hope to identify and to talk with each individual who was directly involved with the decision to purchase the AMT.

The Industrial Adoption Process Model (see Figure 1), focuses the study on the following "dependent" variables (dimensions of the industrial adoption process):

1. The duration of the industrial adoption process
   a. In total
   b. At each stage

2. The use of information sources by the participants in the adoption process.
   a. Most important sources at each stage.
   b. Total number used.
   c. Variety of sources used.

3. The alternatives to the AMT that were considered to solve the problem.

4. The functions performed and the influence exerted by each of the decision-group members during the adoption process.

5. The interaction among the members of the decision group.

In addition, data on a number of "independent" variables should contribute to our understanding of how the industrial adoption process actually works. The independent variables of the study include firm identity variables and decision-group identity variables.

The study asks such questions as the following about the relationship between a firm identity variable and a process dimension: Does the number of professional people employed by a firm affect the speed with which it progresses from awareness to the adoption of the AMT? We suspect that firms with higher proportions of elite or professional personnel have shorter adoption periods than firms with lower proportions of such personnel. The number of elite personnel is a direct measure of the new-idea-seeking people within the firm and also serves as an indication of the firms resources committed to search activity. Assume that the proportion of elite personnel employed by a firm does serve to indicate the duration of its adoption process; this would put the XYZ Company in the enviable position of being able to separate its current sales prospects by gradations of required attention. Those prospects who are likely to buy quickly would receive the more immediate selling attention; those firms that are likely to take longer from awareness to adoption would not be solicited until somewhat later. This information would help XYZ time its promotional communications to the individual companies.

The study also asks similar questions about the relationship between the duration dimension and the characteristics of the decision-making group. For example, does the age composition of the decision-making group affect the duration of the adoption process? We expect to find that it does.

Specifically we expect that young decision-making groups have a shorter adoption period than old decision-making groups. Their later socialization makes for a modern orientation and a greater willingness to try the new. They also tend to be less committed to the old way of doing things. Affirmative support for this proposition would again supply XYZ with important information, especially in regard to the timing of its promotional communications.

A number of additional questions can be raised concerning the duration dimension. Does the firm's age affect the duration of the adoption process? How about the firm's research and development commitment? Does its industrial environment make a difference? Do the economic variables of income, assets, return on plant and equipment, and sales margin affect the duration of the firm's adoption process? Does the educational level or external orientation of the decision-making group make a difference? Are the organizational level and length of company service of the individuals in the purchasing group useful in estimating the length of the period from first awareness to adoption of the AMT? When combined with data gathered on the time within stages and the importance of different information sources within each stage, the resulting statistics should provide key background data for designing marketing strategy. This information should be particularly helpful in developing communication outputs that more closely correspond to the informational needs of purchasing firms.

The composite measures that serve as decision-group identity variables also should act as independent predictors of the role-structure and interaction dimensions. Particular attention is being paid to the various functions performed by members of the decision-making group. For instance, not all members of the group move from stage-to-stage in the adoption process at the same time. Some individuals are evaluating the product in question while others are not yet aware of its existence. Moreover, different individuals may "lead" the purchasing group from stage-to-stage. For example, individual X might be the first one in the group to become aware of AMT, while Y, although aware of it later, is the first to enter the interest stage because it is he who requests the additional information about the product. The patterns of influence within the purchasing group also are being analyzed. Who influences whom? In what ways? At what stages?

Answers to such questions should provide the background information so necessary to the design of more effective marketing strategy. With it, a firm would be in an advantageous position to reduce competitive "noise," to modify the predicted outcome of the adoption process if that outcome appears unfavorable, and to speed up the adoption (purchase) process.

PROMISING APPROACHES TOWARDS UNDERSTANDING TECHNOLOGY TRANSFER

by

James E. Mahoney

Although "technology transfer" has become a term more frequently employed than ever, it describes not a recent phenomenon but part of a process as historic as man himself, his ability to innovate. As we sharpen our understanding of this innovation process, a keener awareness of the significance of "technology transfer" should follow. A purist might trace technology transfer back to the individual who, in the remote past, copied the first wheel, or, with more grandiose schemes in mind, he might indicate early government sponsored programs such as Peter the Great's importation of European specialists in his effort to modernize 17th Century Russia.[1] But in our own country, especially since World War II, the role of technology in our economic growth model has come to be more widely recognized, leading to the establishment of a number of action-oriented, federally sponsored technology transfer programs. For example, since 1914, the Department of Agriculture has operated a county agent system which has proven an effective means of transferring technology.[2] The Small Business Administration sponsors numerous conferences through its field offices. At three of its national laboratories, the Atomic Energy Commission has Offices of Industrial Cooperation. Similarly, NASA has established a number of programs in its experimental technology utilization effort, including the Regional Dissemination Centers. The Office of State Technical Services of the Department of Commerce, operating primarily through designated groups within each State, provides still another example as does the Department of Defense in opening Information Analysis Centers to all industry. With the ever increasing array of complex problems confronting society to which technology can make a contribution and the leveling-off of the resources available for investing in the raw material generation process of technology (i.e., Research and Development which generates the new knowledge that serves as the basis of technology), the pressure to expand these action programs and make them more efficient is increasing significantly.

WE MUST ORGANIZE OUR AREAS OF IGNORANCE

Although all the facets of technology transfer are not completely defined, numerous disciplines are contributing to their clarification and to elucidating the Innovation Process of which technology transfer is a part. Economists are defining the role of technology in our societal growth model;[3] psychologists are anlayzing scientific communication and information exchange in their own field;[4] sociologists are tracing the process through which individuals adopt new ideas and the factors which affect the rate of adoption;[5] operations researchers are trying to understand the interaction of the processes.[6] And information scientists are experimenting with various techniques, including the utilization of computers and index mechanization to assist in the organization of the information contained in the published literature to more adequately fill the needs of all potential users.[7] With the increasing interest of scholars in this area and the realization on the part of the Nation's policy makers of the importance of technology transfer in coping with societal problems and maintaining a growth economy, some thorough introspection is now in order. We must pull together all research findings from the many contributing disciplines into a structured framework in order to 'organize our areas of ignorance' for the guidance of policy makers and for directing future attacks by researchers. While an emphasis on research is proposed by this writer, it is not implied that the action-oriented programs presently supported should be cut back or even constrained at their present level until we know more about the process they are trying to stimulate. Those who would do so overlook the factor that these various programs are generating numerous experiments, the results of which are among the principal inputs to our understanding of the phenomona.

Thus, the prime reasons for structuring our knowledge of this process are as follows:

(1) To provide reference points whereby the scholars of the various disciplines can build research projects in such a way as to properly allocate and utilize our limited intellectual resources.

(2) To provide information to policy makers on the state-of-the-art in this area which can guide them in developing alternative future action-oriented transfer programs and indicate those areas to which added research funding should be allocated.

The theoretical construct which is needed to accomplish this structuring goal must encompass the entire innovation process, including technology transfer, and be able to handle the many dynamic interchanges within the various processes. A research project entitled "Technological Innovation in the Civilian Sector of the Economy," presently underway within the Program of Policy Studies in Science and Technology at The George Washington University has developed a sophisticated dynamic model of the innovation process that shows promise of making a significant contribution to this complex task.[8] While models such as this one and other conceptual tools that evolve in the future will make the accomplishment of this task an attainable objective, various steps which may facilitate their development, acceptance, and exploration should be considered at this time.

NEED FOR A NATIONAL SOCIETY ON INNOVATION

As stated earlier, many disciplines are actively making contributions to understanding technology transfer with the result that their efforts are scattered throughout many segments of the literature. It is imperative to establish a professionally oriented mechanism that can tie the contribution of the various disciplines that shed light on the complex processes of innovation and technology transfer into a unified whole. Included in the tasks of such a national society would be the sponsoring of conferences and symposia to develop communications among the various disciplines and other interest points and the publishing of an interdisciplinary journal. But its major contribution might well be that of providing intellectual guidance to decision makers by establishing a forum for academic researchers, managers of the various user groups, and government policy makers to explore areas of potential promise in a creative, mutually stimulating environment.

EXAMPLE OF STRUCTURAL APPROACH TO ORGANIZING KNOWLEDGE TO ENHANCE A SUPPLY ORIENTATION TOWARD TECHNOLOGY TRANSFER

The action-oriented technology transfer programs have found in a number of instances that technology cannot easily be pushed but, rather, that potential users must be encouraged and educated to the advantages of pulling technology to meet their particular problems, i.e., a supply rather than a demand orientation is more effective in most situations. Potential transfer opportunities are usually compounded by the fact that numerous segments of our society may benefit from technology. Each segment has diverse appetites for technology and varying understanding of its relevance to filling their needs.[9] A micro-electronic group on Route 128 might possibly have a more clearly defined felt need for new technology and a more sophisticated procedure for tapping diverse sources than a sanitation engineering group operating in the Southwest.

A structured organization of diverse research findings contributed by the many scholarly disciplines would help considerably in devising some new approaches to technology transfer. A three-phased approach to such an organization would identify:

1. Characteristics of the users' groups

   Following the identification of the user groups,[10] a number of characteristics must be examined which include:

   (a) A definition of their present technology needs as related to their perceived problems and routine operations.

   (b) An analysis of the present sources of technology which are exploited by the user group.

   (c) An analysis of the procedures available for up-dating and altering these needs as necessary.

   (d) An indication of the attitude of the user group toward the importance of technology in their goal-oriented activity.

   (e) A projection of the user groups' future technical needs.

2. Organize the research findings

   The next major phase in developing the new approaches is to identify and organize the research findings of the many disciplines. This complex coordination exercise must first relate the various studies to the appropriate phase of the technology transfer process and then attempt to associate the study findings to the appropriate user groups.

Some examples of the diverse material which will be encompassed in this phase were discussed earlier and would also include:

(a) Sociologists reporting on the process of a new drug being adopted by a group of physicians.[11]

(b) Economists looking at the impact of new technology on the economy with suggested governmental policies to stimulate technical advances.[12]

3. Developing technology transfer mechanisms

Tying together the research results with characteristics of the user groups will provide insights which should be powerful guides to evolving appropriate transfer mechanisms. This approach, if visually displayed on a three-dimensional matrix[12] should dramatically indicate the extensive gaps in our knowledge, thus providing indicators of areas of research needed.

CONCLUSION

The importance of the innovation process, and technology transfer as an important part of the process, has been widely recognized. It is agreed that the resource, technology, must be managed in an efficient and effective fashion. This paper suggests that the present technology transfer programs should be expanded and particular attention focused on documenting their experience. The output of these activities and the output of research done by various disciplines must be systematically organized by a mechanism, such as a national society that would be able to enhance our understanding of this area, to excite the interest of potential users and scholars, and to suggest the logical courses for future policy decision.

FOOTNOTES

1. Peter the Great developed a people transfer program during his visits to Western European capitals. For example, in 1697, following his visit to England, he returned with: "Three captains of ships of war, twenty-five captains of merchant ships, thirty pilots, thirty surgeons, two-hundred gunners, four mastmakers, four boat builders, two master sail-makers and twenty workmen, two compass makers, two carvers, two anchor-smiths, two locksmiths, two coppersmiths...making with some others not much less than 500 persons." See Barrow, Sir John, Peter the Great, New York, 1900, p. 95.

2. The Smith-Lever Act, 1914, 7-United States Congress, 341-349.

3. Denison, Edward, The Sources of Economic Growth in the United States and the Alternatives Before Us, Supplementary Paper No. 13, Committee for Economic Development, New York, 1962.

4. The American Psychological Association's Project on Scientific Information Exchange in Psychology, Volume I, Reports of work performed under NSF Grant G-18494 from Office of Science Information Service of the National Science Foundation, American Psychological Association, Washington, D. C., December 1963.

5. Rogers, Everett M., Diffusion of Innovations, The Free Press, New York, 1967.

6. Mottur, Ellis, "The Processes of Technological Innovation: A Conceptual Systems Model," Report of the Program of Policy Studies in Science and Technology to the National Bureau of Standards Office of Invention and Innovation to be submitted in January 1968.

7. Kuny, Joseph H., "Computers and Scientific Periodicals," in Automation and Electroncis in Publishing by Hattery and Bush, Spartan Books; Perry, J. W., and Kent, Allen, Tools for Machine Literature Searching, John Wiley and Sons, New York 1958; Welt, Isaac D., "Indexes and Index Mechanization in Biomedicine," Journal of Chemical Documentation, 3, 169, 1963, pp. 169-174.

8. Mottur, Ellis, op. cit.

9. Allen, Thomas J., "Managing the Flow of Scientific and Technological Information," Doctoral Dissertation, Massachusetts Institute of Technology Alfred P. Sloan School of Management, September 1966; Gilmore, John S. and others, "The Channels of Technology Acquisition in Commercial Firms, and the NASA Dissemination Program," NASA Contractor Report NASA CR-790 prepared by the Denver Research Institute, University of Denver for the National Aeronautics and Space Administration, Washington, D. C., 1967.

10. Gilmore, John S. and others, op. cit.
-- they studied the technology acquisition channels in 62 commercial firms within four industries: battery, printing machinery and reproduction equipment, industrial controls, and medical electronics firms. They found that the user group characteristics which assisted in their analyses fall into functional categories, i.e., (1) research oriented personnel; (2) product oriented personnel and (3) technical management.

11. Menzel, Herbert, and Katz, Elihu, "Social Relations and Innovation in the Medical Profession: The Epidemiology of a New Drug," Public Opinion Quarterly, 1955-56, XIX, 337-352.

12. Nelson, Richard R., Peck, Meron J., Kalachek, Edward D., Technology, Economic Growth and Public Policy, The Brookings Institution, Washington, D. C. 1967.

Such a matrix would display different user groups along one axis, factor down the transfer portion of the innovation process along the second axis, and would show the various scholarly discipline sources on the third.

DISCUSSION

Unfortunately, due to the late hour, there was no formal discussion attendant to this session.

SESSION NO. 7

THE ROLE OF FEDERAL GOVERNMENT PROGRAMS

Chairman:
Dr. R. T. Watson
President, ITT Industrial Laboratories

Moderator:
Mr. George J. Howick
Director, Technology Utilization Division
NASA

Panelists:
Mr. Edward Brunenkant
Director, Technical Information Division
AEC

Dr. Monroe Freeman
Director, Science Information Exchange

Dr. Paul J. Grogan
Director, Office of State Technical Services

Mr. Marshall Grotenhuis
Director, Office of Industrial Cooperation
Argonne National Laboratory

Mr. Charles McCabe
Director, National Referral Center
Library of Congress

INTRODUCTION

Dr. Watson opened the session with the following reference to part of Indiana's role in the space program: "We're in a situation where the fifth lunar orbiter is successfully on the way to the moon. And being from Indiana, I'm pleased to say the sensing modules that provide the guidance for taking these orbiters to the moon were made at our Industrial Laboratories. I always like to hit the successful ones."

SUMMARY OF INTRODUCTORY REMARKS BY GEORGE HOWICK

In commenting on technology utilization, Mr. Howick suggested that the term "spin-off" may give the wrong connotation in that "spin-off" implies lack of deliberate effort but technology utilization requires much such effort. He defined the primary concern of the panel to be the deliberate transfer of technology; the movement of knowledge across disciplinary lines, regional lines, industry lines, or lines of market orientation--or any other boundary that would normally impede the progress of knowledge diffusion. He suggested that logic alone tells us that technology does contribute to economic growth. It must contribute at least in improving productivity; thus enlarging the discretionary income available to people, so that they can purchase additional products, based on new industries, based on new technologies transferred in from outside that industry or firm. To illustrate that technology does contribute, he pointed out that nearly everything that makes up our material world has come about in the life span of the current generation--and that most product and process changes have technological origins.

SUMMARY OF REMARKS BY MONROE FREEMAN

Dr. Freeman characterized the role of the Science Information Exchange as that of providing information for research management. He quoted activity of the Exchange as follows: an input of one hundred and twenty-five thousand records of currently active research a year; about three million information elements stored in the computer; about fifty thousand questions answered each year for scientists and engineers throughout the scientific community; about eight hundred thousand copies of research documents are requested and sent out. These records cover all areas of life, physical engineering and social sciences. They come from the federal agencies, private foundations, universities, industries, and some foreign. A one page document describes, in some detail, who supports the research; who does it; where, when, how much, and a two hundred word technical summary. These records are revised, renewed and updated annually.

About twenty to thirty data elements are extracted from each document or record and coded into the computer. From this data bank, a vareity of information products, each tailored to the specific request is retrieved. These may be simple requests for a few documents, tabulations of data, large computer print-outs, or printed catalogues covering broad subject fields such as water resources. He said the water resources research catalog for 1967, which they are working on now contains data on about 4000 projects. In a survey of 1000 users, 95 per cent learned about new research which they hadn't known about. Seventy per cent said they used the information to avoid unknowing and unwarranted duplications.

He pointed out that extending this management concept to the program level of management responsibility is much more complicated. The director of a multi-million dollar program has neither the time nor the staff to read and analyze thousands of research summaries that are pertinent or related to his broad program. This is further complicated by the inter- and multi-disciplinary elements of research appearing in other fields that are peripheral to his own. To illustrate his problem he hypothesized three situations: one where the program is well contained and peripheral relationships are identified, one where two projects are defined to avoid duplication, but in so doing, innovation opportunities may be lost and the most common situation were common interests are recognized. The latter gives rise to such questions as: Is the overlap too much or too little? If too much, it may mean useless, wasteful duplication. If too little, it may mean lost opportunities. What are the number of projects in this area of common interest? What is their nature? Who supports them, government, industry, academic or others? Should the managers coordinate or cooperate on these projects, by exchanging information or by sharing research support? These are only some of the management questions that arise at the program management level.

To further emphasize this he showed data taken from a partial compilation of projects related to the field of Isotope Development. About 1200 projects selected from the S.I.E. files were distributed among nine sub-fields of interest. The number of projects in each sub-field supported by different kinds of research interest was listed and the differences of objectives were given. The objectives of government, in general, are national problems. The objective of industry is ultimately profit. The objectives of the academic world are generally exploratory research and the search for new knowledge. It was pointed out that data of these types, when coupled with technical knowledge of the field, technical resources, and with program priorities can guide the manager to the particular sub-fields that are most attractive for his purposes. This offers him a more rational choice of the sub-fields that might be scrutized more closely.

The process proceeds logically from a comprehensive over-view of a broad field of interest to the details of selected targets with the economy of his time and effort. This general approach to program management information is being explored by S.I.E. Dr. Freeman suggested that it is the logical kind of extension of the kind of management information that has been successful at the project level.

SUMMARY OF REMARKS BY PAUL J. GROGAN

Mr. Grogan identified the origin of the State Technical Services Act as stemming from President Johnson's statement to the Congress in his 1964 economic message: "The federal government should join with private business and our universities in speeding and developing the spread of new technology. I've directed the Department of Commerce to look into this." At the subsequent signing ceremony for this new legislation in September, 1965, President Johnson further stated: "The test of our generation will not be the accumulation of knowledge. In that, we have exceeded all of mankind that has gone before. We are committing ourselves to an orderly application of the great technical and scientific break-throughs of our times." Mr. Grogan observed that substantially this same quote had been included in Congressman Roush's dinner speech Monday evening. He also related to the potential of the OSTS program to the potentials of the agricultural extension program.

He identified six attributes of technological change that constitute the major premises underlying the State Technical Services Act:

1. Technological change has caused imbalances in our economy.

2. Technological change has caused obsolescence of manpower and machines.

3. Technological change has become a driving force behind the growth of our economy.

4. Technological change abroad makes foreign competition more of a factor.

5. Technological change, as in the example of the automobile and air pollution, has impaired some aspects of the quality of life.

6. Finally, technological change--if properly managed--has the capacity to correct many of these unfavorable attributes of change itself.

He cited the latter function, the management of technological change for the improvement of the social milieu as well as growth of the economy, as a primary mission for OSTS. In the discharge of its function of administerir Public Law 89-182, OSTS must try to be instrumental in giving direction to technological change so that undesirable side effects don't necessarily follow from what we normally term progress. He emphasized the underlying assumption that economic growth is related to technological innovation; that growth in the private sector is important and desirable to match, indeed to support, the growing public sector needs of our country.

He emphasized that the Office of State Technical Services operates in partnership with the states. It has largely a funding responsibility for programs conceived, conducted, and supported on a matching basis by the States. The basis for this program across the country is that the problems and the needs and the opportunities, with respect to introducing new technology into the private sector, are most appropriately identified at the state and local level. Each state has its particular problems with its peculiar opportunities and potentials, and no one is more concerned about these problems or better qualified to do something about them than the people in the states themselves.

Mr. Grogan cited the role of institutions of higher learning, consultants, research laboratories and research institutes as resources available at the local level. He emphasized the desirability of broad participation by all of the qualified institutions and organizations in each of the states. The federal government can provide the initial incentive in the support of these programs. But the state government, the institutions, the professional people, and the user himself, all must share in the cost associated with this endeavor.

He identified the primary benefits expected to flow from the program as increased productivity and rate of return upon investment, more even distribution of the sophisticated advanced industries in all regions of the country, increased employment opportunities resulting from stronger companies at the local level, more satisfying products and services for the consumer, and greater strength of American goods and services in international trade. He suggested second level benefits including that American business and industry will remain strong in the face of the world competition, that we remain in the forefront in the application of science and technology, that the United States with its desire to assist the developing nations can fulfill these commitments and still take care of needs at home, and that the balance of payments problem may be kept under reasonable control. At the third level of benefit, he suggested a better quality of American life. Problems of congestion, pollution, and the dissatisfaction with the built-in obsolescence of many consumer products will fade into the distance. Finally, out of the increased use of technology at local levels, there should develop more attractive and economically viable communities in which to live and work.

He quoted the following statistics on OSTS programs: 24 programs were approved in fiscal year 1966 and 41 state programs this year. The amount of federal support to individual state programs ranged from something under \$50,000 on the low end to \$300,000 on the high end for the larger states. The average state program consists of some 16 projects funded at a level of \$90,000. The projects are distributed among administrational, educational, informational, referral and demonstrational services.

The level of effort for the dollars expended on these programs is not necessarily in any way proportionate to the number of projects themselves. More than 60 percent of the approved activities are of an educational nature. Most of these are of short duration, two days to two weeks, and have very little stand-by costs or continuing costs associated with them. Therefore, they represent only 33 percent of the cost in the program. One project in eight is an informational project, yet 23 percent of the resources go into such services because of their continuing basis involving full-time, professional personnel.

Field services, something we discussed yesterday on several occasions, represent about 10 percent of the projects and account for more than 20 percent of the funding. Field services are expected to grow as the program matures. When the state has assurance that the program is going to continue at a given level of funding, they will be able to make the necessary commitments to full-time people to carry out field service and the industrial liaison work the program entails for problem identification and solution. There are not enough trained persons immediately available to move into the industrial liaison work. They have to be identified, trained, and convinced, or otherwise persuaded to go into this kind of work.

Mr. Grogan offered the suggestion that it is highly desirable for the field service people to have an institutional base rather than that of a government agency, whether it's state or federal. He was of the opinion that their ease of entry into the industrial plants and their acceptance by local industry will be much greater if they operate from an institutional base.

Mr. Grogan then discussed the Special Programs Division, which over the past two years has made 19 grants. Forty-six percent of these dollars went to educational institutions and a like amount went into industrial associations. The majority of the activities are of an informational nature, where an industry association serves all of its members with recent information.

He then discussed the difficulty of measuring the cost-benefit aspects of this type of program. He cited an example from the state of Florida.

The Florida State Technical Services Program, concentrated heavily upon the building materials industry and how to get improved products and methods into these firms. This had led to the development of a lightweight, modular building unit derived from locally available aggregate. As a result of impetus from the technical services program, followed by developmental studies done at the Engineering Experiment Station at the University of Florida, someone in Florida now has enough confidence to engage in the manufacture of this new product. Plans now call for the construction of a pilot plant to see what success can be obtained with this new building product for which a local market of 600,000 tons per year has been estimated.

This is but one example of potential business success deriving from the short experience of OSTS. There is every reason to believe that this program in time and with federal and state support, in the words of President Johnson, "will do for American businessmen what the great Agricultural Extension Service has done for the American farmer."

SUMMARY OF REMARKS BY EDWARD BRUNENKANT

Mr. Brunenkant emphasized that the AEC's regular programs for the peaceful uses of atomic energy comprise more than half of its budget; utilize a far larger share of its personnel; and involve some of history's most significant examples of government development of technology for industry. The outstanding example is, of course, the development of nuclear reactors for the generation of electricity. He stated the Agency objectives as: to improve the general welfare; increase the standard of living; and strengthen competition in private enterprise. He said this charter is broad and probably difficult to accomplish in anyone's given lifetime. Primary impetus for the

Agency to undertake the initial development in the nuclear power field was in order to bring down its cost to the point where industry could take over the technology. For certain types of reactors, this has now been accomplished. He cited other AEC programs which have large industrial potential: uses of nuclear explosives for such purposes as excavation, earth moving, and metal extraction; and the development of industrial uses of radio-isotopes and radiation.

While AEC's regular programs have, for quite a few years, been producing important industrial technology, he suggested that a number of potentially useful innovations may have been developed which have not been exploited to their fullest potential. Any large scale development program is likely to have such concealed nuggets. Here he emphasized materials able to withstand unprecedented pressures and temperatures; containers that will not leak even one drop; equipment that will not be corroded by highly corrosive coolants; and enormously complex instrumentation able to detect unusual conditions and to operate independently without human intervention. As a consequence of meeting these challenges, Mr. Brunenkant suggested that there may well exist within the AEC a treasure-trove of innovations which can be exploited for purposes other than the nuclear related ones which prompted their development. These may include new or improved techniques, products, devices, materials, processes, systems, machines, apparatus, fixtures, tools, or instruments.

At this point he introduced the concept of the AEC Offices of Industrial Cooperation. There are now two of them, at Argonne National Laboratory and at Oak Ridge National Laboratory. These offices act in various ways to bring industry and the respective laboratories together so that they can be helpful to each other. They try to promote individual industry--laboratory contacts that can result in actual technology utilization for commercial purposes. They conduct briefings and tours of the laboratory for industry and trade groups. The Office at Argonne acts as the focal point for the publication, jointly with NASA, of a series of business-orientated summaries of innovations developed at Argonne, known as AEC-NASA Tech Briefs. They are distributed by both agencies and sold for a few cents at the Federal Clearing House. This fall an Office of Industrial Cooperation will be established at Sandia Corporation. This is unusual in that Sandia is one of AEC's major weapons sites. This new office will be concerned with technology born in an almost wholly classified atmosphere and will try to find out what kind of problems are associated with this additional barrier to technology transfer.

He then discussed another program unique with the AEC whereby AEC contractor employees can serve as consultants; industry can use AEC facilities, services and materials for private work; and the employees of private industry can work at AEC sites to gain experience in unique processes, techniques and developments.

SUMMARY OF REMARKS BY MARSHALL GROTENHUIS

Mr. Grotenhuis emphasized that the big transfers (reactors and isotopes), cited by Mr. Brunenkant, are nuclear transfers directly from a nuclear orientation to a nuclear industry. He pointed out that there are also lots of non-nuclear transfers from nuclear research centers. These include the "clean room" development, which took place at Sandia Laboratories, and the remote manipulators for handling radioactive materials, which originated at Argonne. The accelerated amount and pace of research today has led us to the point that we can't handle technology transfer by the old procedures. We should study the situation, production of ideas and need of ideas, to see what, if anything, needs to be done to improve the flow of ideas to a useful conclusion.

He next emphasized that the Office of Industrial Cooperation is more concerned with non-nuclear transfers, partly because that is the new concern of the AEC and partly because the nuclear transfers have been actively promoted for some time and also are more obvious. He suggested that the Office of Industrial Cooperation represents a personal contact point at the laboratory site. One of the most effective transfer mechanisms is a face-to-face contact between the scientist or the engineer who has developed something and the man who is going to use it or develop it. The Office of Industrial Cooperation provides such a meeting ground. As one vehicle, he cited a series of pilot conferences co-sponsored by the Small Business Administration. These have been successful but they have so far stopped at the awareness stage.

He also cited the Tech Brief program with NASA. The question is how to get ideas to industry. He said that the Office of Industrial Cooperation had actually proved in several cases that prior publication really does not reduce the value of a Tech Brief very much. Publication in a journal does not necessarily reach all people that it should. Among other reasons, publications most often answer questions that have not yet been asked and, as a result, attract less attention. Therefore, there is a definite value to a Tech Brief, even if it refers to something that has already been published--published as an internal report or as project reports, as well as formal publications.

He then discussed the Office of Industrial Cooperation's efforts to contact people more efficiently. This seems to require talking to people who have a larger sway of influence within the group, for example, the executive secretary of a professional group. He, in turn, can do a much better job with the group that he represents than can the Technology Utilization Office. He closed with the suggestion that the biggest impact of the Office of Industrial Cooperation in the area of technology utilization will not be the big things such as reactors, but rather they will be a multitude of little things. The day-to-day phone calls, the day-to-day letter answering, the day-to-day talking to people by such centers as the Office of Industrial Cooperation, will have a far greater cumulative effect than many realize.

SUMMARY OF REMARKS BY CHARLES MC CABE

Mr. McCabe indicated one of the functions of the National Referral Center is to tell you where you can go--to get needed scientific and technical information. The National Referral Center is now five years old. It has a staff of 29 and a budget of about $370,000. About half of the staff are professionals.

He said the Center is a register of information resources. Information resource means any organization, institution, group or individual with specialized knowledge in a particular field, and a willingness to share this knowledge with others. The Center will not register as an information resource, an organization which will not share information.

At present, about 8500 information resources have been registered. 98% of these are in the United States. New ones are appearing at the rate of about 30 per week. That the probable eventual size of the register is estimated to be between 20 and 30 thousand can be questioned, but there's no doubting the fact that the register is now growing. As far as can be foreseen, it will continue to increase for several more years. From the register, the National Referral Center provides a referral service, publishes directories and prepares studies relating to information suppliers and users.

He said the Center has been offering referral services for about 4½ years. During that time, more than 10,000 request have been received. In the three months just ended, (that is, ended last Monday, July 31st) requests were almost 70% higher than they were in the corresponding period of 1966. July alone showed an increase of 94% over last year. He emphasized that the referral service is free. In response to a request, an inquirer is directed to an information resource capable of supplying the information which is needed. The inquirer is given name, address, telephone number, and if possible, the name of an individual he should contact. He is also told what services he should expect and whether or not there is a charge for the service. Because it's more economical and definitely more satisfying to the inquirer, he said the Center prefers to answer requests by telephone. He then discussed their "feedback" effort. Three months after an inquiry has been answered, the inquirer is asked to fill out a simple form, evaluating the services. Fifty-five per cent respond. Of this number, about 85% indicate that they did get the information they needed through one or more of the resources.

He said about 41% of all requests come from commerce and industry. Individuals without any known affiliation constitute 18%; federal government agencies 23%; educational institutions 13%, and professional societies 5%. Thirty-seven per cent of all the requests are in engineering and technology; 27% are social sciences; 16% in biological sciences; 12% in the physical sciences, and 8% are miscellaneous.

He then discussed the use of the register to furnish raw material for directories. To date, three directories have been published. The first one covered the physical sciences, the biological sciences and engineering; the second one social sciences; the third was a specialized directory on the subject of water. The first one has sold over 14,000 copies. It is now in its fourth printing. The second directory has sold almost nine thousand copies and it's now in its second printing. The third one has sold about 7000 copies since last September. The next directory will be a directory on the information resources in or sponsored by the federal government. It will contain a listing of about 16 to 17 hundred sources of information. A directory of toxicology information resources is underway he said. Mr. McCabe then discussed a third use of the register--the preparation of compilations and analytical studies. These are done exclusively for "in-house" use or for the National Science Foundation.

SUMMARY OF REMARKS BY GEORGE HOWICK

Mr. Howick presented a brief over-view of the NASA technology Utilization Program. The program has four principal purposes. First, maximize the return on the public investment in aerospace and development; second, shorten the time gap between the discovery of new knowledge and its effective use in the market place; third, move knowledge across lines or barriers between disciplines, industries, regions, restrictions, and market orientations; and fourth, in the process of achieving the first three, experiment to improve the techniques for the transference of technology.

Specific activities he cited included first, in order to support NASA's own scientists and engineers, and those of its contractors and grantees, NASA collects on a world-wide basis the results of aerospace-related research and development. This document collection dating from 1962 totals nearly 300,000 documents. They're indexed, abstracted, "micro-fiched," taped, and otherwise processed to make an accessible information bank.

The second resource discussed flows from the 14 major field installations. Each has a technology utilization office. This office is charged with two tasks: to identify, evaluate, report and document those inventions, innovations, improvements, discoveries and other forms of discreet new knowledge that originate within the field installation; and to monitor a new technology reporting clause in every NASA contract or research and development. This clause obligates every NASA contractor to report to NASA the new technology generated in the course of his work under the contract.

He then addressed his attention to methods of dissemination. The most common known mechanism is a Tech Brief. This is a very brief announcement--one or two pages--of a technological advance--an invention, improvement or discovery. The Tech Brief aims at describing the invention in brief, and then explaining the concepts and principles underlying the invention. The principal means by which a Tech Brief is called to the attention of someone who might use it is the business and technical press. Seventy per cent of the inquiries result from having read about the Tech Brief in the press. Inquiries are now running at an annual rate of 14,000 per year. Obviously, the technology has relevance to the commercial economy.

He then discussed the Technology Survey. In many cases, NASA has had to make major contributions in an area of technology in order to meet its mission objectives. Where this happens, an authority in that field is commissioned to write a survey of the technology. This becomes a guide-book to the state-of-the-art. It points out those developments, those trends, those new pieces of knowledge in that field that have broad utility and leads the reader to sources of additional information, whether they're people, institutions, or documents.

He then discussed the regional dissemination centers. The pioneering computer based center is the Aerospace Research Applications Center at Indiana University. The eight regional dissemination centers are located at universities or not for profit research institutes. All are obligated to stand the test of the market place. They must become self-supporting on the basis of industrial fees for services rendered. He pointed out that the fee is not for the information. It is for the value added by the center. The center's ability to help define the problem or objective and convert that into a search strategy that overcomes the many language barriers between industry and the aerospace data bank; and then to reach into this bank of three hundred thousand documents, and pull from it only those reports that are directly relevant to the problem as defined. There are now about two hundred seventy companies paying annual membership fees to these centers. This is more than double the number a year ago.

The membership fees range from $150 per year to $20,000 a year at present.

Next, he discussed a project aimed at maximizing the return on NASA's very large investment in computer "software." Many millions of dollars are invested by NASA in the development of computer programs each year. Many of these have additional utility. The University of Georgia's Computer Center is now disseminating these programs to industry. Charges equal cost of reproduction, distribution and overhead. This too is to become a self-supporting activity.

Mr. Howick then discussed an effort begun aimed at transferring space technology into the fields of biology and medicine. Bio-medical Application Teams, are located at three non-profit research institutes. These teams have the task of establishing inter-institutional relationships with groups conducting medical research at universities, clinics, research hospitals, and federally-supported laboratories. The Bio-Medical Application Team assists the researchers in defining those barriers that are impeding the forward progress of medical practice. They then specify these identified problems in a non-disciplinary, functional terminology, so that the physical and engineering scientist can help to solve the life-science problem.

Next, he cited a number of inter-agency agreements. In one case, space technology is being applied to problems of crime prevention and law enforcement by working with the Office of Law Enforcement in the Justice Department. In another case, joint efforts are working to help in physical rehabilitation and retraining through cooperation with the Social and Rehabilitation Service of the Department of Health, Education and Welfare. Other joint efforts include weather modification and a program for the development of curriculum enrichment materials for graduate engineers and physical science courses at universities.

He stated the underlying philosophy of the technology utilization program as experimental. The desire is to prove a concept, then let someone else pick it up and run with it, someone who has a mission in that field, whether it be a federal agency, a professional society or whoever. Mr. Howick concluded by identifying a member of successful technology transfers. These included a peel tester to determine the strength of an adhesive bond between two materials; a magnetometer developed at the Goddard Space Flight Center, which is now being commercially marketed by a company in Massachusetts with projected annual sales of 30,000 per year; the application of the Gemini helmet to collecting exhausted breath for analysis to set proper exercise levels for children with respiratory diseases, a method to detect the existence of Parkinson's Disease at a much earlier stage than was previously possible; and lunar surface photographic enhancement techniques applied to enhancement of x-ray photographs of the brain.

DISCUSSION

QUESTION: How do states get started under the state technical services program?

GROGAN: Within each state there are a great many institutions that are potentially qualified to participate in the program. The decision at the state level usually is that if you wish to participate in the annual technical services program you must be prepared to furnish the matching money. This has been a condition for initial operation of the program since the typical state really doesn't have a pool of money lying around for such purposes.

On the other hand, OSTS is able to provide the initial incentive by saying to the states that we would like to have your ideas with respect to participation in this national program. The State Technical Services Act of 1965 permits the award of a $25,000 planning grant as an initial contribution in order to help get the program started in any given state by identification of needs and potentials and the development of both a five-year set of objectives and an initial operating program.

In the absence of a state appropriation to support the operating program, the administrative and coordinating unit responsible for the program in each of the states simply asks the participating institutions to provide the necessary matching funds as a show of faith that they wish to take part in the program.

There is a second feature to this program that comes about very naturally. Educational institutions naturally might be expected to participate in an educational program. These offerings very often have a registration fee associated with them. The participating institution need not match with institutional contribution if they don't have the resources immediately available or it isn't clear how they might convert existing resources to these purposes. They simply can come up with the user fees as the matching funds. This requires a gamble, a risk taking on the part of the institution, that the fees will materialize in abundance when they perform these services. In some instances, participating institutions have been somewhat embarrassed by generating fees for technical services and educational offerings that are in excess of their expectations. I have reference now to money that has been earned through the program. The way the act is written, the institutions then have to convert the excess income to use for another technical service. However, I don't think the requirement for the generation of matching funds as a consequence of institutional participation poses any particular hardship on the individual institution. In addition to fees generated as a consequence of the service offered, they can count facilities and services of their own personnel that have gone into the program.

QUESTION: Can you specifically tell us how the Florida project came about?

GROGAN: As I recall, a study had been going on at the University in the general area of rendering assistance to the stone, clay, and glass industry of the State. A study of lightweight aggregate potentials through this effort made information available that this kind of product could be produced from existing raw materials in Florida. A conference for the stone, clay, and glass industry under STS auspices pointed out these potentials to the participants. It turned out that a particular building materials manufacturer was interested enough in the prospects to go ahead with a pilot plant to try making this product out of existing materials. As I said earlier, if the pilot venture proves successful, it is expected that the annual market for this new product will be on the order of 600,000 tons.

QUESTION: Did private companies supply most of the funds to bring this to reality then?

GROGAN: I would say that the product and its potentials have been turned over to a private company for development. I do not know what licensing arrangements or agreements there may be.

QUESTION: Well, how does your department and the state cooperate in this development?

GROGAN: As I understand the relationship, this was something that the university had been working on for some time under the research programs in its Engineering Experiment Station. But the transfer of this knowledge to the private sector took place as a result of a conference scheduled under STS sponsorship.

QUESTION: George, as I noticed the slides you were giving and the Tech Briefs, they were showing forms of technology transfers and ideas that were published. But I also understand that NASA, through their systems approach, their reliability factors, and other management development concepts have developed some very key insights to management operations systems programs. But how do you get that out to management?

HOWICK: One of the key experiments under way is right here at ARAC. It's a management information service. Chuck, would you like to describe it just briefly?

MULLIS: Here at ARAC we have some experimental programs under way, which follow the same pattern we've been using for several years in getting technical information out to industry. We try to put together what we call a profile of this information. In other words, get together and record current data in one particular subject area--management science; and present it to interested persons in industry. The subject area here is a very broad one. There is a profile on operations research, a profile on quality control, a profile research and engineering administration and others. We tried to select a course that would be of interest to the manager who is technically orientated. We're finding very good reception to the program so far. It's experimental, we've got a lot to learn about it. We think it's progressing well.

QUESTION: I just wanted to put in one plug here for the association (Chicago Association of Commerce & Industry). We have a program where we run about 800 meetings a year for management and other people for about 15,000 companies in the Chicago area. We have very close contact with management. A lot of their problems are very basic problems. A group of the business professors might not want to waste their time with it. And that's not a derogatory statement; it's just a fact. The difficulty is getting these smaller companies to take the time for these programs. It would seem that maybe somewhere along the line, NASA could take a look at some of the bigger associations; primarily those that are related directly with business; as a possible output for the input that you have among these various programs.

HOWICK: We are doing that at present with several industry associations and professional societies. We'd be delighted to work with more.

QUESTION: I'm David Fax with Westinghouse. I'd like to refer a question to the Referral Center. There's no question but that your interpersonal method of handling questions and directing them to source of information works wonderfully well. But if you succeed and move from the relatively unknown to the almost known; what happens then? Have you given thought to whether or not you can maintain the same kind of switching center; or would this ultimately result in a building say the size of the Pentagon. How would you handle success?

MC CABE: Well, we've been moderately successful so far. We estimate that a referral specialist can handle about 20 to 25 request per week. If we get above that, then we begin to be pushed. We are now approaching this upper limit, and we do have to get another referral specialist. In other words, for about every 25 additional requests, we will need another referral specialist. Is this what you meant?

QUESTION: Yes, I think that solves it initially. And will it remain linear? These referral specialists will soon have to interact with each other and take each other's time.

MC CABE: Yes, that's correct. Back when we first got started, we estimated at that time that a referral specialist could handle about 15 request per week. With the increase in his experience and knowledge and background of what is now available in our register, they are now able to handle 25 per week. So that at the same time you're increasing your number of requests, you're also increasing the efficiency of the referral specialist. Further, we hope, that when we do get all of our data on tape, that the product of the computer will be of great assistance to the referral specialist.

QUESTION: I was wondering if the Science Information Exchange of the National Referral Center, you have analyzed the profiles of your users to see if you have similarities and differences in the profiles of these users?

MC CABE: From the Science Information Exchange, we don't attempt to return the profile of the user. A user has a very specific question. One may want all current studies on the enzymes of insects. Another one may want some specialty in cancer or in materials engineering. We threat these things as all special requests. There probably is no profile. In other words, research and research interests of people, in basic and applied research, their activities are not exactly standardized.

QUESTION: The reason for my question is because we have heard, a little earlier in the Conference, about the lack of knowledge on the part of the scientific and technological community concerning how to tap information sources. It would seem to me that the profiles of those people now using your Center--Referral Center--might give a little better feel for who now knows a little bit about resources versus those who do not. This would help guide those who want to go to the ones who don't know how.

MC CABE: We can tell you, for instance, what percentage of our requests are coming from librarians, scientists, administrators, grade school teachers, high school teachers, students, graduate students, etc. We can't tell you at the present time how many of these librarians are located in federal government agencies or colleges. We will be able to do this hopefully within the next six months. At the present time, all we can tell you is that, based on the statistics that we have at hand, that so many of our requests; that I guess it's 20 to 30% are librarians, and so on down the line. When we get this all on tape, we will be able to tell you not only where they are located, what their broad area of interest was, but what their specific area of interest was, and how they requested information from us; whether it was by telephone or letter.

FREEMAN: May I add to this? This is the type of profile you meant? I thought you meant the individual. In the Science Information Exchange our products range all the way from something that costs a dollar to a water resources catalog that cost $40,000. In terms of the dollar output, about 64% goes to federal, about 18% to universities, and a small percentage to hospitals. And this was a year ago. With the year just closed, the commercial inquiries from industrial research have almost doubled; more than doubled. This gives you a general idea.

QUESTION: We have here on the panel people from NASA, the Department of Commerce, the AEC and the National Science Foundation. There is also some activity at the Federal Clearing House and in DOD. And this is just the federal government. There are lots of other sources of information in private and non-profit institutions. Does the panel see the sources of technical information growing and proliferating more? We've seen this vast array of different agencies involved in transferring technical information. And it seems that this continues to grow monthly. Do you see that there will be an amalgamation of these coming together into, maybe a super information center? Or will there be the continued growth of the specialized individual centers?

MC CABE: I can give you a personal opinion. Undoubtedly there will be growth. There always is. We all have parochial views. We are all interested in furthering our own interest. But I don't frankly know whether or not it's going to be a vast increase in the number of informational resources. I feel myself, that we are now merely on the verge of establishing a network. I think we have at the present time, an informal or semi-formal network of information sources. You ticked off a number of informational, federal governmental resources that we know about. When we get a request where we feel the answer can be contributed to by the Science Information Exchange or the Clearinghouse, or the Science and Technology Division of the Library of Congress, we go ahead and answer that request in the way that we normally would answer it. That is, provide points of contact. And if we feel that the man asking the question can benefit by a listing of resource material available to him; we will send that request to the Science and Technology Division of the Library of Congress. Commit them to an answer, and they will put in four hours of free time to compile this listing. At the same time, if we feel that the man can benefit from knowing what on-going research projects there are in his particular field, we will send that out to the

Science Information Exchange, and we will commit them to an answer. We will do the same for the Clearing House. And in the reverse, if they get a request that they think we can contribute to, they will send it on over to us. While I don't personally foresee a large formal type of network, I think we are on the verge of having established an informal or semi-formal type right now.

BRUNENKANT: Well, I tend to believe that there will be a national system. The national system will be in terms, however, of a very large body of data, as separated and distinguished from specialized information centers. I think specialized information centers, such as which utilize a large body of information for specialized purposes, will continue to grow and will be evaluated as we become more sophisticated. Specialized centers will, as time goes on, become more compatible with and articulated into a national system. Furthermore, the national system, in the long run, must be a subsystem of an international system. Because the U. S. today, certainly in our field, is contributing no more than 30% of the total of whatever you want to call it: Literature, technology or research. I think that the problems involved in an international system are political and not technical at the present time.

FREEMAN: We've been working with perhaps a dozen information systems in working out the technical problems of a network system, for example, the Highway Research Information Center with the National Academy. We were working on a formalized agreement with them for the exchange of input material, and on the basis of the service. In other words, you're serving a lot of different purposes here; a lot of different audiences. This is the real problem. If the Highway Research Information Center can answer all the questions of research engineers, this is just fine with us. We need their material in water resources, transportation, problems of urban affairs, and many other inter-disciplinary things of this sort.

GROTENHUIS: This was a question that came up in the Office of Industrial Cooperation quite soon. We decided that our job was to provide information on Argonne and/or the AEC. However, there is no way of telling people what to ask us about. Our approach was to be able to tell people where to go for information from any government source in addition to what we had at Argonne and the AEC. I believe that this is the kind of service that will have to exist. I believe that this is where we get close to being that agricultural type agent in a local area. The OIC has been serving that function in the Chicago area as much as we can possibly spread the word. I don't think that this is our primary mission although maybe it could be. I think there should be such a center in Illinois, maybe several places in Illinois. We do plan to take this up in the State Technical Service meeting with our Council and Advisory Committee this fall. I think that the information center is a crucial point, because the potential user must have an entry point into the system. Where does this guy go? The confusion of government agencies is something that you're never going to teach everybody. You can teach one guy locally. And then teach the companies in a local area where to go with a question. This is what we've tried to do in OIC.

GROGAN: The Office of State Technical Services is often talked of and thought of as an information service. But we're really not a source of information. We're a user of information. As this program operates, the first point of contact with the potential user of information very probably is through the field service person we talked about yesterday and again this morning. This man is the modern counterpart to the county agriculture agent whose success in technology transfer for agricultural purposes is well documented. This man has little information to sell himself. He might solve the problem right there in his discussion with the industrialist, or he may refer this person to an education program through which the necessary insights can be obtained. That educational program may not be a great user of information. Many educators feel reasonably confident operating within their own discipline without great dependence on federal sources of information. But I think we could do well, perhaps subtly over a period of years, to influence these people to take a look, at least, at what's in AEC and in NASA; at what's available in the Clearinghouse, etc., to make the various presentations more meaningful and more up to date.

Going back to our system, then, we often resort to the on-the-spot judgment of the field service agent for solving the problem. The next level of endeavor may be an educational program or a referral of the field service agent in search of a solution. Finally, we might be expected to turn to a specialized source of information for an answer. In this sense, I would think that AEC is a specialized source of information; NASA, broad as it is, could be considered to be such a source of information. It will take time and experience before we take on character as a great information system wherein the programs we support can generate interest and cause the flow of information and movement of material from outside the immediate sponsorship of projects.

HOWICK: I think that it's very clear that everyone is working toward a national network. And as one more specific example, the regional dissemination centers can respond to a given applied problem, and will frequently supplement the available NASA information with public and private sources of a wide variety.

QUESTION: I'd like to direct my question to you, George. You mentioned the three Bio-Medical Application Teams helping non-profit organizations. What are the locations of these teams?

HOWICK: At Southwest Research Institute, Midwest Research Institute and Research Triangle Institute.

QUESTION: I noticed with interest one of the comments at the Conference here, that the Japanese have been one of the most successful countries in the utilization of new technology. In our enthusiasm for technology utilization, are we missing some things on the foreign response aspects in the same way that the people that built the automobile didn't realize that we would have air pollution? I'd be interested in what responses from foreign countries, and what you see concerning them.

BRUNENKANT: Are you saying that the foreign countries are more effective in utilizing AEC generated technology in terms of time scale? My guess is that that's only true in a limited number of instances. A committee, which studied the technology gap generated a tremendously large report concluding that the technology gap really should be characterized as a management gap.

QUESTION: I'm interested, not necessarily in the area of developing Asian relations. I know that they do have a management gap. I'm not so sure about the Russians. Is this a danger?

BRUNENKANT: I think the question you're suggesting has very large political overtones. There are a number of people in Congree that are concerned that American technology is going to be more effectively utilized, not only by the Japanese, but by the Soviets. When you talk about transfer, you're talking about the differences in the conflicts between collaboration and competition. This is a particular sensitive area in the nuclear field. There's no doubt that the American government is interested in assisting American manufacturers sell reactors all over the world. To do this, we must communicate our technology. On the other hand, we have relationships in terms of any development, disarmament, and preventing proliferation of nuclear weapons which argues against communication of certain technology. This is a field in which there's no "pat" answer. There's going to be continuing dialogue about this, not only in the executive department, but between business and federal government, and between international licensees and their partners in this country. I don't think anybody can give you a really sound answer.

QUESTION: I'd just like to hear a little bit about NASA's posture on that one.

HOWICK: We believe that we should encourage the free flow of scientific information, internationally. But we also believe that because of the immediate utility of the "raw" technology, its benefits should accrue first to those who pay for it; i.e. the U. S. taxpayer. Now, this does not mean that we would not exchange that "raw" technology for an equivalent; some new and useful "raw" technology originating elsewhere. The exchange of information internationally is something we pursue routinely.

QUESTION: I'd like to direct a question to Marshall. Internally, within the OIC, how do you look for these bits and pieces of information? What search technique do you use to try to locate these gragmentary pieces?

GROTENHUIS: We were forced to start looking for pieces as soon as we started to cooperate on the Tech Brief program. Gus Milak started this. He started first looking at patents, and then at the laboratory reports and publications of the laboratory. He didn't look at the titles but rather what they stood for. He looked for that which is of a practical nature, which is not part of the research project, but is part of the support that went into it. He's still doing that. The other area that we intend to cover is the drafting rooms. We want to find out what kinds of drawings there are, and which ones might be practical. Of course every time he contacts one of the staff members in the laboratory, he points out what he is doing. Nine times out of ten, they volunteer two or three more ideas which they think are good. We encourage this type of thinking by making a publicity program of the Tech Brief internally. We want to make sure that our people know about Tech Briefs, our own as well as NASA's, and also to give the originator of the ideas a kind of a "at on the back." We list the Tech Briefs in the monthly house publication that we have, so that the guy's name shows up. We send memoranda to the Division Director saying "so-and-so" contributed a Tech Brief. All of this encourages him to come up with ideas, without us having to look for them.

QUESTION: You tell me you've only got one man doing this research?

GROTENHUIS: One man.

QUESTION: One man for the whole OIC?

GROTENHUIS: He's looking at the Argonne program.

QUESTION: How about the rest of AEC, anybody else?

GROTENHUIS: Sam Snyder is producing some at Headquarters. I don't know if Los Alamos is producing any yet or not.

BRUNENKANT: We're going on a laboratory by laboratory basis, trying to utilize the distribution system that NASA has set up, because it would only make sense from a federal point of view. There's no one attempting to analyze the whole AEC. My own conservative nature would lead me to believe that the probability of success on an AEC-wide basis would not justify what would be required. Additionally, people in Washington tend not to be that close to technology, in terms of what's really going on with our national laboratories.

QUESTION: What kind of people, with what backgrounds, are you looking for to do this search? Now, how do you find a person on a Commission staff that is tuned enough to industrial needs to know what to look for?

HOWICK: We've got about 43 of these folks. And this is about the most heterogenous collection of people that you can find. They have a couple of traits in common. One is that they have a sufficient background to recognize when something is new and significant. We never try to prejudge the utility. We think that would be a great disservice to the audience, if we try to tell them what it's good for, because you lease them down that path to the discouragement of the path that may be the most profitable for them. Prejudging the application of the technology is not the function of the technology utilization officer. His function is to determine whether it is novel and significant. These are pretty good interviewers. They know how to ask the right questions. They also have supporting them, the whole scientific and engineering staff of the field installation. And the principal concern of the technology utilization officer is to motivate the scientist and engineer to report; not to do the seaching and reporting himself.

QUESTION: NASA's doing a much more thorough job here than the Commission from what I've seen of it. And your answer, from NASA's standpoint, didn't really answer my question about the Commission.

HOWICK: The Commission just got started. Argonne has one of the highest "batting averages" of anybody in the program. They're doing an outstanding job. They got started faster than any of our field installations. So I want to answer for Ed in that I think his approach has been very good.

BRUNENKANT: I think George has said everything I could possibly say. Normally, we would rely upon our laboratories. We don't hire people for our laboratories. We tried to guide ourselves by the experience that NASA's had. NASA's been in this longer than we have. We're also trying some approaches that NASA, either because of its law or because of its orientation, can't very easily do. We don't see any real point or net gain in duplicating everything that NASA does. I think that the benefits to that kind of an approach would be kind of minimal, because they have the money and the energy, and certainly the backing of their lab, and they have the support of their Congressional Committee. There are still lots of people in our own agency who are extremely suspicious that technology utilization is only a public relation's dream.

END OF SESSION

LUNCHEON SPEAKER

Richard A. Carpenter
Science Policy Research Division
The Library of Congress

SUMMARY OF REMARKS BY RICHARD A. CARPENTER

Mr. Carpenter began with an analysis of the attendance at the conference. He determined that about 22% were from industry, 8% from the not-for-profit research institutes, 12% from the federal government agencies, 36% from universities, 9% from state and local governments, and 13% from the other endeavors. Another breakdown showed that 15% were concerned with the transfer program, the direction, administration or promotion of transfer programs. About 60% were transfer agents in one form or another, and about 25% were users or final receivers of technology. He made this analysis to emphasize the breadth of the problems and success associated with the process of technology transfer. It would seem that a lot of new faces, and a lot of different angles were represented. He emphasized that it's very important to have these heterogeneous discussions, because the government role in supporting information banks and overt transfer efforts is open to discussion from many sources. Mr. Carpenter performed a study for the Sub-Committee on Science and Technology of the Select Committee on Small Business of the United States Senate. The subcommittee was chaired by Senator Jennings Randolph. Mr. Carpenter proceeded to discuss some of his experiences during the performance of that study.

In 1953, the Committee held meetings on the impact of technology on the economy. Also, the National Security Industrial Association held a very informative series of seminars. The study was a follow-on, to see what the status is today of the rather vague and confusing concept of transferring technology from its original purpose to a secondary use. The Committee does not have legislative jurisdiction over the NASA program or the OSTS program; rather they are performing the other function of the legislative branch in over-viewing programs that have been created by legislation, and presenting information to the rest of the Congress, so that future changes, or appropriations, or authorizations can have the benefit of this Committee's reports, hearings, and deliberations.

He pointed out that the Congressional concern was mirrored also in the Executive branch of the government. The Director of the White House Office of Science and Technology recently wrote to Senator Randolph: "One of the great tasks before our society is the determination of the appropriate governmental role in stimulating and guiding technological change in the service of man. This is not an issue to be quickly decided. Debate, analysis and pragmatic experimentation must proceed simultaneously. We must consider the costs and benefits of expanding the federal support for the development of basic civilian technology, of strengthening local information transfer activities, of providing direct assistance to new technologically based industries. I for one, would like to see a greater participation in the debate by a whole spectrum of individuals drawn from business, non-profit institutions, local and state governments, and universities."

He then discussed the views of the congress on the quantity and quality of federal technology that is available to transfer. In the first place, there would be no single comprehensive statement that would represent a Congressional view. Unlike the Executive branch, where there is one power center; in Congress, each Senator and Representative considers himself a power center. Consequently, there are 435 shades of views required to represent the Congress. His remarks were therefore labeled as his own resulting from talking to some of the Congressmen that are interested in technology transfer.

The concern is certainly not to cut off appropriations for this program, or that one if the results can't be shown down to three decimal places. It is a political fact that there will be an increasing demand for some sort of quantitive analysis of competitive transfer methods, and for a determination of just what we are getting out of the experimental programs to date. Certainly, we are beyond the "enchanted" state that is produced by movies and "road" shows. The Congress wants to know a little more precisely what the game is worth. However, the concern is a positive one on the part of those members of the Congress with whom Mr. Carpenter had talked. They want to know if we can move a little faster; if we have not identified methods that are cost effective; and should not all federally controlled information be included in the transfer system. There are questions of the uniformity of the federal policies among the agencies and toward the business community.

To stress the positive interest and concern of the Congress, he related some of the conclusions that were reached in the staff report. For instance, it is clear and accepted that public funds generate about 2/3 of the available technology, and that government has a responsibility to get full benefit from this knowledge.

It's also beginning to be increasingly documented that second applications are appearing, and that federally derived technology does have appreciable utility in industry and other public programs. Therefore, we are beyond the question of "why technology transfer?" Federal government efforts are warranted in devising and operating programs to make new technology ready and available to all users. At the same time, the "how" of technology transfer still is in a quandry. There is no uniform practice or policy in the agencies. There does not seem to be any trend towards one. Additional public discussion and formulation from both private and public sectors is necessary.

The lack of feed-back from users of new technology makes it difficult to evaluate the transfer methods. He admonished the conference to keep in mind the necessity for feed-back. This feed-back or cost effectiveness information, although it may not be quantitative, will begin to answer the question which follows why and how; and that is: whether to continue technology transfer in one mode or another. Should we have a federally centralized program versus continuation of individual agency programs? Should we leave it to the private sector entirely? Should we consider technology transfer as only a special case of special science information handling? Should we generate special efforts for small and/or specialized businesses?

Next, he commented on the over-simplified concepts for discussing technology transfer. Technology is related to business problems. Although his committee is a small business Committee Mr. Carpenter pointed out that they don't recognize that adjective in any narrow sense. For instance, American Motors is a genuine small business. Certainly technology transfer may be a very insignificant factor to a great many businesses in the country, but it may be helpful. Some technology may be helpful to some businesses. The small business generalization is unfortunate and inaccurate.

The second over-simplification is that technology transfer is of interest because of its relationship to economic growth. He emphasized the fact that technology transfer has other dimensions than economic growth, and these are very important to national policy for transfer programs. The entire political attitude and public opinion towards science and technology is in one of its periodic shifts. The new challenge is in the anticipation in the public mind that social problems can be solved through applied science. This is very important to technology transfer.

This concept seems to have culminated from two major positions in the past. In the 19th Century, technology developed quite independently of science. In the 20th Century, science began to grow, but still quite independent of technology. But now, technology is dependent on science. And the distinctions and separations of support are becoming blurred and less useful than they were in the past. He pointed out that budgetary distinctions of basic research, applied research, development, test, and engineering, etc., are becoming more difficult to maintain. He suggested that, despite the occasional "bleatings" from the "ivory towers," basic science, for its own sake, is virtually a thing of the past. This conclusion was based on the fact that the world and our lives are so entirely technical, so involved with applied science, that the scientist cannot live as a person without being constantly aware of the needs and opportunities for applying what he's doing. Even if he is such a dreamer that he can isolate himself from reality; he probably has a wife and some children around that are going to bring him "back to cases."

Another reason for this shift is that the magnitude of the dollars going into science and technology brings public and political attention to what can be done with this knowledge, whereas before the war, it might have been dismissed as just another thing that people in the universities were doing. But twenty-three billion dollars a year is reason enough to cause many politicians and the general public to become interested in the results of science. Another reason for this change in attitude is the "back lash" of the consequences of technology as evidenced in the Tory Canyon disaster, or the air pollution problem, or some of the other unwanted by-products that result from technology and change.

Mr. Carpenter suggested that the faith and awe that have characterized the public and political attitudes in the past are becoming changed through an ability to "look science in the eye" and ask science for help. Returning to the business scene, he pointed out that the stock holders of many corporations are past the point where they're content to see a picture of the research lab on the cover of the annual report and some vague descriptions of what they're doing. They're demanding that industrial research produce results. He also referenced one possible alternative to this change in attitude, the occasional call for a moritorium on science, because no one can consider the situation very long without recognizing the absolute dependence we now have in the world--not only the countries in the world that are the "haves," but also in the "have nots."--on science and technology for salvation. The population explosion, the mobility of people, etc., have led to complex ecological problems that can only be solved by science and technology. Also, an existing resource in manpower, management, organizations, and facilities has been established that it would be folly to dismantle. This lead him to a conclusion of more and not less support for science and technology.

He summarized the Congressional viewpoint in four points. First, there is a real wariness that must be dispelled as to how the free enterprise system can be reconciled with the large government control of science and technical information. Second, Congressional attitude is somewhat more positive. That is, there's an inherent "Yankee thrift" aspect to looking at technology transfer. A third point is that science and technology information, and technology transfer are going to cost a great deal of money. The fourth point is the political fact of life that, whether we would all agree with it or not, the technology transfer concept is going to come up for increasing review by the Congress and by the industrial public. Overt activities in technology transfer by federal agencies must eventually gain the backing of the Congress.

The Committee structure is such that the small programs, as at present, don't arouse the interest of any vocal pressure group and are dealt with almost with a whim by Committee chairmen. Mr. Carpenter suggested that many of us recognize the contrast in attitude towards two of the major programs as they've been handled by the Congress in this past year. Perhaps the difference in attitude is one of arbitrary reaction and personal pique or personal interest. He pointed this out to indicate the importance of demonstrated, documented results in transfer. A reliable feed-back from users must be obtained, as difficult as this may be. He observed that this very valuable concept has slipped from the status of a few years ago of vague cocktail party anecdotes to become the subject of business school sociological, psychological theorizing in research, without ever achieving, in reality, factual accomplishment. He stated concern for the post-NASA and the post-OSTS phase of this concept. We'll eventually need a great deal of money to do this job. More than can be "boot-legged" or protected in an agency budget. . . . This is a part of the total technical and scientific information program, which must be looked at by industry and the Congress. It must be looked at as a whole. When it receives this scrutiny, which may come in the hearings which Senator Randolph poses, or may come later on in budget authorizations or appropriations, the more facts that we can all produce, the better off we'll be. He urged all programs to concentrate on documentation and use data pointing out that certainly no change in ways of doing business is easy to be a part of. But, it is a gratification to be in on change, when it's important and when it is occurring. He concluded that by the time very many more of these meetings come and go, we'll all be proud to have been here.

SESSION NO. 8

FINANCIAL INSTITUTIONS

Chairman:
Neil D. Skinner
President, Hoffman Specialty
Manufacturing Co., Inc.

Moderator:
E. E. Edwards
Fred T. Green Professor of Finance
Indiana University

Panelists:
Charles F. Haywood
Dean, College of Business & Economics
University of Kentucky

Jack L. Wagner
Vice President, Equity Research Associates

William K. Wittausch
Manager, Housing Research
Stanford Research Institute

INTRODUCTION

Mr. Skinner introduced the theme of the session by commenting on the changes that have come about in how financing institutions process loan inquiries. He pointed out the aggressive competition that has developed between loaning institutions seeking new business. The addition of technical specialists to the staffs of loaning institutions, whose job it is to investigate and advise on the technology underlying investment opportunities, was emphasized.

He then introduced Professor Edwards.

FINANCIAL INSTITUTIONS, TECHNOLOGY AND ECONOMIC GROWTH

by

E. E. Edwards

The lead article in the current issue of the Harvard Business Review criticizes economists for their neglect of technology and for their failure to recognize the importance of innovation. I do not recall any similar article deploring the inattention of economists to the role of money and financial institutions. Nor could such criticism be justified since economists have long emphasized this area in their research and writings. But I can report some difficulty in finding very much in the literature treating collectively the three subjects for today's discussion: financial institutions, technology, and economic growth.

Neither financial institutions nor technology, I suppose, should be considered as desirable goals or ends in themselves. Both are means for the achievement of other and presumably more desirable objectives. Some might argue that technology is more than a means to an end, but I doubt that this would be true for financial institutions. Economic growth presents more difficulty, since obviously it is a means to an end, but it may also be a desirable goal. In any case, I have chosen to look upon economic growth as the end to which both financial institutions and technology must contribute to justify their place in the scheme of things.

For today's discussion we are not primarily concerned with the role of financial institutions in promoting economic growth, nor with the role of technology. Rather, we assume these to be generally understood. What we must consider are the inter-relationships of our three variables, asking ourselves such questions as these: what can financial institutions do to aid or retard technological development? to promote the application of new technology? what effect is technology having on financial institutions, especially with reference to the performance of their most vital function, the assembly and allocation of financial resources? what is economic growth doing to the technological-financial institution relationship?

I do not propose to answer these questions, but as moderator of this afternoon's panel, I hope that I can provoke some answers from the panel members. Before giving them any opportunity to speak, however, I shall try to sharpen some of the issues. Let me begin by considering some obvious and direct impacts of technology on our financial institutions.

The most significant aspects of technological development lie outside the operational area, despite the rapid and almost complete change which recent technology is making possible in the way financial institutions perform their routine operations. Whether we do in fact become a checkless society, for example, may have far less impact on our economy than whether banks use their lending power to finance new ideas. On the other hand, the movement toward a checkless society may change the consumption function--the propensity to spend rather than to save--hence the rate of growth of financial resources, hence the ability of financial institutions to exert any direct influence.

Whether mortgage lenders use modern decision theory, aided by access to the most sophisticated computers, or continue to rely on rules of thumb may be relatively unimportant as compared with their attitude toward new designs, new materials, new concepts of community living and other elements of change. And because of the important role financiers play in business, government and other organizational efforts, technological change at the operational level in financial institutions contribute little to economic growth as compared with the results of the leadership the executives of financial institutions could exercise throughout our economic, political and social structure.

Bankers and other financial executives have had at times a reputation for trying to maintain the _status quo_, and for looking with disfavor on change of any kind. Many of them have tried to justify their "conservative" attitude by citing their responsibility to "conserve" the capital entrusted to them. In a society of rapid technological development, trying to maintain the _status quo_ may require the acceptance of unbearable risk, the risk of technological change. In any event, what happens to our financial institutions, and the impact our financial institutions have on technology and economic growth, will depend to a large extent on their executives' attitudes toward change outside rather than inside the institutions.

Several years ago a well-known Chicago banker suggested that "banks will always have plenty of dumb-bell jobs and plenty of dumb-bells to fill them." He, like most of us, probably foresaw a growing use of bank services, books to be posted, and statements to be balanced. And like most of us, he failed to see just over the horizon the automatic reader and sorter, and beyond that the computer which would . . . or could . . . eliminate checks altogether. Banks may no longer have any dumb-bell jobs, hence no need of any dumb-bells. But does that mean they will not have any? What effect will automation of routine operations have on top management? How will bankers and other financial executives adapt to an environment in which there are no dumb-bell jobs?

Having a computer available, and one or more bright young men or women to program it, should lead to the use of the computer for something other than mass handling of simple transactions. Modern theories of portfolio selection, of risk analysis and risk avoidance, and other top management decision-making can now be applied to financial problems. For example, some institutional investors appear to be using the new technology for timing "switches" in their security holdings. But if bright young men use their theories and the computer primarily to seek market gains, the impact for economic growth may be far different than would be the case if financial institutions pursued somewhat different objectives.

Let's suppose, for example, that bankers--and here I use the term broadly to include executives of all types of financial institutions--move rapidly in the direction of favoring new products, new processes, and other new demands for financial assistance. Let's assume, too, that they consider research and development costs as assets rather than expenses, and human capital as "bankable" as plant and equipment. Would this bring greater economic growth or merely more rapid obsolescence of our present capital? Or would it jeopardize the solvency and continued existence of our financial institutions? How do bankers learn what technology to bet their money on, and how much? Can they use new technology to fit apparently high risk projects into a "safe" portfolio?

Answers to these and related questions may depend in large measure on what laws, regulations and examiners permit financial institutions to do. Government attitudes toward financial institutions and their regulation may in turn depend on how rapidly new technology can be applied in the supervisory area. Examination of financial institutions without much doubt is an obsolete means of communication between the supervised and the supervisor. A widely held concept that no institution be allowed to fail may give way to a far different idea that too few failures suggest the acceptance of too little risk in the allocation of financial resources.

Technology in the years ahead must offer solutions to such problems as air pollution, water pollution, disposal of wastes, elimination of slums, and intra- and inter-city transportation. Technology without money will not suffice, however, and financial institutions must accept a major role in the financing. The difficulties in this area become apparent when we read that mutual savings banks in New York City are trying to get the state legislature to extend the geographical limits of their lending in order to have adequate investment opportunities for the savings they generate. How can money and technology be directed into areas of such obvious need as making New York City a better place to live?

A society which develops few new products and few new means of making old ones may offer fewer investment opportunities than needed to match planned saving, hence achieve little or no economic growth. On the other hand, a society that offers new products and new ways of making both the new and the old may encourage both spending and investment, hence achieve a rapid rate of economic growth but not without price inflation. If this, rather than the former, describes our society, what is the proper role of our financial institutions in equating savings and investment? Can technology help in the stimulation of saving? How shall scarce resources be allocated?

Research and development and the application of new technology in existing firms will depend largely on attitudes of corporate directors toward change. Many corporate directors are executives of financial institutions. Other directors hold their position either directly or indirectly as the result of stock ownership of financial institutions. One result of this "banker" influence may be a more cautious approach on the part of industry toward technological change. On the other hand, it may well be the director with the financial background who sees the danger in not doing research, in not employing scientists, in not discarding old ways.

If it is true, as I suspect, that other business firms are ahead of financial institutions in the application of computer technology to basic problems, exposure to the possibilities for more sophisticated application of their own computers will begin to affect all kinds of decision making in financial institutions. When banks and savings associations, most of which are dependent largely on local markets, begin to construct econometric models of their local economy, the impact of this kind of technology may be very far reaching. Such models not only give the financial institutions the opportunity to improve their own performance, they also enable the community to find solutions to its problems and to plan more effectively for the community's economic growth. The information a bank has, or would have if it had recorded it, offers an almost unbelievable opportunity for development into a knowledge system for effective community action.

This has been an incomplete and rambling presentation. I hope it will provoke some worthwhile discussion, but first let's hear from our panel members, at least some of whom may want to make an opening statement.

SUMMARY OF REMARKS BY CHARLES HAYWOOD

Dean Haywood's remarks focused mainly on commercial banks. He first summarized the technological situation in banking as a case of technology transfer--a case that might warrant some study and research, that would give some insights into the process of technology transfer. He emphasized the impact of new technology on commercial banks in changing their modes of operation and altering their lending policies.

He pointed out that for the past decade technology transfer has been going on in commercial banking on a large scale. It had its origins more than a decade ago, but it was only about 1957 or 1958 that significant numbers of banks began to alter their technology. The beginning really came with the recognition in the early 50's that the amount of paper work, particularly check processing, in the years ahead would become staggering. He cited a Bank of America projection, that if they were to use the same procedures in the year 2,000 that they were using in the early 50's everyone in the state of California would be employed as a bookkeeper. Hence, change was mandatory.

He then pointed out the trend in the last four or five years for banks to exploit the new technology beyond handling their own transactions and to become service organizations performing certain routine operations for their customers.

Dean Haywood distinguished the "big" technology to which he referred from numerous innovations that have been applied to commercial banking operations, such as design of bank buildings, personnel training, and various other "small" techniques that have been developed to improve commercial banking. But the big technology is mainly the computer and its applications. He divided this into three sub-systems: First, the data processing applications of the computer, the rote automation of the routine processing. These include the automation of routine processes of bank customers and automatic credit transfer systems. The second sub-system under big technology is management information systems. Central information files within the bank is one dimension of this; inter-company systems is another. These would include information systems for bank customers, and also interlinked credit information systems, where the credit bureau in the community might well be able to tap a source of information within the bank computer. The third sub-system has to do with the policy structure of banking and with management decisions. In this area he cited simulation as a way of studying bank decisions, illustrating bank decisions or teaching something about bank decisions. Concerning the computer as a case of technology transfer he distinguished between hardware aspects of the computer and the software aspects with the major problems of banks being in the software.

A second type of technology cited was tele-communications. New developments with respect to tele-communications are very pertinent to the application of new technology to commercial banking. He mentioned records where it isn't enough to pick up the telephone and call headquarters; one must actually reproduce the document wherever the transfer is going to take place. Consequently, tele-communications combined with reproduction technology is important to commercial banks where they're operating some distance from each other. Another area mentioned was systems analysis. The general field of statistics and mathematics were cited as the underpinnings for the management science approach.

He then addressed himself to the present status in commercial banking with respect to the adoption of the big technology. For the most part, commercial banking is still in the first stage. That is, they're still working on the data processing application; the use of the computer to handle routine procedures. He quoted recent statistics surveyed by the American Bankers' Association which indicate that, in 1966, 7% of the banks in the United States had computers on their premises. However small this number may be, he pointed out that these banks accounted for 67% of the total deposits of the commercial banking system. Fourteen per cent of the commercial banks were using computer facilities off premises; service bureau arrangements. These 14% accounted for 10% of the deposits of the total banking system. Ten per cent of the banks indicated that they were planning to go to computer applications, either on premise facilities, or service bureau. These 10% accounted for only 5% of the total deposit. Thirty-one per cent of the banks in the country in 1966 were in some stage of automation of their routine procedures. This 31% accounted for 82% of the total deposits. That leaves 69% of the banks which had no plans at that time for automation of routine procedures. But that accounted for only 18% of the deposits. To defend this structure, Mr. Haywood pointed out that the large banks are finding the applications more economical, or the costs are more within their reach.

It's estimated by 1971 almost all banks which have deposits of $10,000,000 or more (about 7,000 banks, about 40 to 50%) will be automating their deposit accounting, most of them probably using off-premises facilities.

He commented that this is not only a function of size, it's also a function of the type of business which a bank does. A small bank in a metropolitan area is much more likely to find the need for automating its procedures, or find it an economic undertaking, than a bank of the same size located outside a metropolitan area in a predominantly rural area. He then considered the area of management information systems. In 1966, only four banks in the country reported that they had central information files. Some of the larger banks have experimented with the portfolio management techniques, but it's very limited in its adoption.

He observed that commercial banking has a long way to go in the adoption of new technology, but it has come a very long way in ten years. How was this achieved? First, there was a recognition within the industry of a need for better procedures and more efficient procedures. Second, the larger banks were prepared to make a very large investment in equipment and in people. Third, there was industry-wide participation.

This was not so much the case of an innovator, it was inherent in the processes. For instance, check clearing has to be pretty standard around the country. There had to be industry-wide participation. This came after 1955. One of the key things was the agreement on magnetic ink character recognition and upon the type of print and characters to be used. This required industry-wide agreement on standards and tolerances. Banking was able to accomplish this through its rather strong national organization; that is, through the trade associations, particularly the American Bankers' Association. He pointed out further that the American Bankers' Association established a department of automation, which is now seeking to disseminate information on computer technology and to conduct an educational program for commercial banking.

A fourth element involved a transfer of people. Some banks took experienced personnel and trained them in the uses of the computer; trained them as programmers. This experiment was not satisfactory except for isolated cases. Most banks hired someone trained in computer technology and then taught him commercial banking and banking operations. This has resulted in a great improvement in efficiency but no reduction in total cost. The growth in volume of work to be done has overtaken all of these banks in the process of shifting over to the new technology.

Dean Haywood emphasized that unit costs have gone down in many cases. There has been built into some banks a tremendous capacity for handling volume transactions. There has been a very great improvement in accuracy as a result of the adoption of the computer. There have been some shifts in employment. He pointed out as a for instance that bookkeepers are going out of existence in banks. Many large banks don't carry that classification any more on their personnel roster. Programmers have come in along with various types of equipment operators and research people.

He suggested that it's hard to say what the net influence has been, because the economy and banking system have grown at the same time that all of this has been taking place. Perhaps the biggest thing is the opening up of new dimensions of services for commercial banks, particularly in the consumer credit field. Relating this technology transfer to economic growth he suggested that one can only speculate on the effect on consumption and saving. The effect may be one of increasing consumer expenditures, which has both its advantages and disadvantages as far as growth is concerned.

Dean Haywood next distinguished between organizational and technological changes. Commercial banking has gone through various organizational changes. Innovation can take the form of changes in organization and procedure, as well as changes in scientific technology. He was primarily concerned about branch banking here. This is an organizational innovation dating back to the early 20's. Some states permit branching, some don't. The question he raised was does the technology imply there will be the need for branch banking to develop to a greater extent in order to take advantage of the new technology? Another question involves technology coming up against legal restraints.

He then discussed new systems which might permit banks to better assess their risks or to take more in the way of risks. One of these developments which various banks have been experimenting with is credit scoring as a way of evaluating loans. A certain criteria is established with respect to the installment borrower. He is interviewed and points are assessed depending on his answer. If he rates out over 80 points, you grant him a loan. If he comes up with, say, 60 points, he fails the test, and you don't grant him a loan. This permits quantification of any degree of risk that you might want to take assuming that the criteria are really pertinent.

Dean Haywood concluded with reference to the discussion in some circles of commercial banks becoming information utilities. Commercial banks have access to a great deal of information about their communities, and their customers. It is quite conceivable for a commercial bank to develop an information system, a data bank, which would include all the useful information about the community, about the state, perhaps; about the customers; and to use this to supply information to various users. It could be of use to their industrial customers in the planning of their marketing and production. As fiduciaries, commercial banks presumably could be trusted to be the 'caretakers' of information banks. Some banks have gone to the point of assessing what it would cost to undertake this type of operation. The cost is pretty staggering. But, it is something which the new technology will permit.

Finally he stated that there has been an impact of new technology on commercial banking that has changed commercial banking operations. These changes spell out, or indicate, that commercial banks will change their role as agents assisting in the transfer of technology in our society.

SUMMARY OF REMARKS BY JACK WAGNER

Mr. Wagner first described Equity Research Associates as one of two independent research firms on Wall Street. It serves approximately 125 New York Stock Exchange member firms and a dozen or so Mutual Funds, many of which are normally referred to as performance funds. Their work is distributed in approximately 14 foreign countries. He stated their basic function as providing useful information for clients.

During the last two years, Equity has devoted a considerable amount of resources to trying to earmark what's going to be the investment market of the 1970's. Where are the future Xerox's, Polaroid's, I.B.M.'s, Litton's going to come from? He pointed out that the investment market of the last five years has been one in which good investment concepts have made money and bad investment concepts have made money. He suggested that the next five years are going to be a little bit better for good investment concepts and a little bit worse for bad ones.

To perform this projection task they looked at all the functions of corporations. From this they developed a theory of "free form" management. He amplified this with an analogy from the world of sculpture from which the term was borrowed. Free form basically derives from the fact that the public is pretty well convinced that in an age of science and technology just about anything can be done. This public not only exists in the United States but also overseas. There's a great deal of confidence that the United States can do just about anything.

Concerning the rate of change, Mr. Wagner said there's no question that industry today doesn't realize the tremendous number of important projects on the "back burners." They're ready when the time is right. The question is, who's going to bring it out first? Also becoming important today is not only who's going to bring it out first in the United States, but who's going to bring it out first in the world? This is a very complex consideration.

He then pointed to the question of management. Change will not sustain the same "...fuddy-duddies that have been diddling around for the past ten or fifteen years, and watch the profit margin go down and down, with a heavy personnel turnover..." He suggested that if management can anticipate change, perhaps it can get something done. And maybe get it done in one-tenth the time anybody else gets it done. He observed that there are no such managements around. Mr. Wagner defined "free form" management as management that is now willing to change; integrate change, anticipate change; do something about change, and not just react to change.

He then discussed the basic characteristics of free form management. Free form is not a structure. It's a management philosophy. It requires a systems approach to management problems and opportunities. As an example, he cited the Ogden Corporation, which was a pretty dead operation five years ago, but is starting to move ahead now. This corporation is gearing its entire acquisition program to an economic model of the corporation involving not only where it is today, but where it's going.

Another characteristic of free form management is an R & D commitment. Mr. Wagner admitted this to be a vague concept and suggested as a substitute a commitment to new ideas. So frequently the only measure recognized in the financial community is R & D expenditures as a percentage sales. He suggested a more meaningful measure might involve the relationship between R & D expenditures and pre-tax operating profit.

The final characteristic of free form management involves participation in markets of major opportunities. Most of these are identified directly with social need; air pollution and how to fight crime for instance.

The above markets then lead to a type of corporation which is going to be multi-industry. This is currently termed the conglomerate type of corporation. Here he distinguished between free form, a philosophy of management, and conglomerates, a type of structure. There are many conglomerate companies around; but they're dead, because they don't have an awareness philosophy.

He next discussed various control agencies; The Federal Trade Commission, the Anti-Trust Division of the Justice Department, Senate Committees, etc.; and how they view conglomerates. The body of law is fairly well built up in horizontal mergers, vertical mergers and reciprocity. Conglomerates are not included. Some control agencies are staffed by persons who feel that every merger is bad, right across the board. However, Mr. Wagner suggested that the conglomerate has a very positive value in our economy. The top two to three hundred corporations represent the so-called technological lead in our economy. These have the largest number of professional people and they produce the greatest results. If the little fellows can combine together and get the benefits of a talent type of "mutual fund" of a conglomerate type of corporation, they will also benefit.

He stated that in the United States, more and more of the companies are getting interested in this. But more important, in Europe, there is a great deal of interest. They see this as the way they can bypass the traditional structures of American Corporations, because they've always looked at the U. S. as having a paternalistic attitude in many of the major corporations.

Mr. Wagner concluded that these corporations with free form management philosophy have a very great role in today's economy. They're going to be able to get things accomplished in a fraction of the time that some of the large ones are.

NEW TECHNOLOGY IN FINANCING HOMES

by

William K. Wittausch

Innovations developed by the defense and aerospace industries are being applied in research to stimulate the growth of the housing industry. One such innovation is an approach, rather than a specific solution, for the handling of problems in housing finance--the software rather than the hardware technology of housing.

I have purposely chosen to discuss this aspect of housing because it is always overshadowed by the more colorful engineering innovations in the way we produce buildings or bring land into residential use. How we finance housing is actually more important because the cost of money takes 42¢ out of the consumer's housing dollar, compared with 33¢ for costs related to the building facilities and 25¢ for costs related to land. This breakdown, incidentally, is itself a result of looking at housing the way the military does, namely, as a system of providing people with shelter.

Housing is a $100 Billion Annual Business

The housing system in the United States today includes just over 60 million households, living in as many dwelling units of different types, sizes, and quality, which on the average cost $1,500 per year in rent or mortgage payments. This represents an expenditure of close to $100 billion per year for the nation as a whole.

This $100 billion represents one-fifth of the total personal disposable income of American families. It is more than we spend on defense every year. Despite this impressive expenditure for housing, however, it is no secret that for years the housing industry has been in a slump which no demographic reasoning, such as a declining birthrate or later marriage, can explain away.

SRI Looks at the Housing Industry

About five years ago Institute staff members began to ask why, at a time when the market for everything else the consumer buys was going up, housing was barely holding its own. The Institute has for several years been engaged in research for private industry aimed at examining a possible restructuring of the system to a form that would enable housing to become a growth industry--one that expands faster than the population.

Taking this total approach, the housing industry's mission is to produce, finance, market, service, and maintain, year after year, an expanding housing inventory as the population grows, incomes rise, and mobility increases.

I will not dwell on innovations that relate to the building process or land development, but on innovations related to the financing of housing. They are less dramatic, to be sure, but probably more significant because money is the most important building material. Also, because housing is consumed over time, credit is the lifeblood of the housing industry.

Housing is a Private Business Opportunity

We will look at housing finance in terms of: whose money is invested? how much? on what terms? for repayment by whom? when? and how fast? Let us accept as a point of departure these three premises: First, that under our private enterprise system, private industry should, as a goal at least, be capable of supplying private citizens with private housing at a competitive price, in a free market.

Second, that in the United States we have moved from an agrarian, rural society, where land meant food and food meant life, to the money economy of an industrial, urban society, where income means savings and savings mean credit which, in turn, sustains our living standard.

Third, that the human mind, both urban and rural, identifies the possession of one's home with the right to exist on this earth in dignity and freedom. This instinct to own one's home has produced the pioneers' log cabins in the mountains, the farm homesteads in the prairie, and the millions of savings-and-loan financed homes in cities.

It is no accident that the fantastic productive power of the United States is matched by the widest distribution of individual property in the world. But this blessing does not permit us to rest on our laurels. On the contrary, we should strive to extend the security that home ownership implies to even more people by improving our home financing concepts and techniques, but we must not sacrifice the sound principles and experience on which these concepts are based. It is in the updating process that technological transfer comes in.

The Systems Approach to Housing

One of the technologies that is transferable from the military is the systems approach. Analogous to the mission of the Department of Defense to provide and maintain our national security, for example, the housing industry's mission is to provide and maintain the shelter our people require.

Another technology, this one developed to the highest level by the aerospace industry, applies to the maintenance aspect of housing. Airlines, for example, maintain a transportation service for consumers that supplies a time and place utility, not unlike housing. They think of their end product as "seat miles," that is, the services rendered in delivering a person in a given period from one place to another for a given price. Taking this same point of view, housing might begin to think of its end product as "housing years," that is, the services the industry renders in supplying the consumer with a dwelling in a given place for a given period at a given price. Introducing this time concept adds a new dimension to the housing business.

Maintained Performance in Housing

Once consumers learn to think of housing, like transportation, as a product that serves over time, the housing industry will begin to sell its product not for what it is, but for what it does--performance maintained over time, in other words. The consumer will then begin to buy his housing more for the pleasure he gets out of living in it than for the capital gain he might get selling it.

Because this concept is gaining acceptance, it will also change the way industry conducts its business. Instead of retailing housing to individual consumers the way we do today, the housing industry could retail it through a new type of organization whose function would be to build, buy, own, and maintain housing facilities for individual families who wish to rent, buy, or own their homes.

The Housing Estate Corporation

Such an organization is the housing estate corporation. As far as the consumer is concerned, the housing estate corporation would combine the functions of builder, realtor, lender, and manager of residential property into a one-stop service. In dealing with such a corporation, the consumer would have more choice than he has in today's market. After selecting a particular home offered by the corporation, making a deposit, and agreeing to monthly payments that include maintenance, he would have at least four types of occupancy agreements to choose from: He could rent with or without an option to buy, or he could buy with or without a mortgage. Renting without an option would cost the least per month; and renting with an option, slightly more. Purchase with a buy-back guarantee would cost the most, and purchase without a buy-back guarantee would fall somewhere between, assuming mortgage costs are the same. The buy-back guarantee assures the buyer the return of his down payment plus that part of his monthly payments which goes to amortize the investment in his property. Giving the consumer these choices for any type, size, and quality of dwelling that is controlled by the housing estate corporation eliminates two important constraints to marketing housing in today's mobile urban society--commitment to one type of tenure and the requirement for a deposit that the consumer is not always prepared to make.

The housing estate corporation would own and operate a large number of residential properties in much the same way that organizations today manage industrial or commercial property. A resident in a housing estate would make his monthly payments to the corporation. In return he would be entitled to notify the management for needed maintenance or repairs and to apply his accumulated equity toward another house when ready to move or receive his equity in cash.

Managing a Billion Dollar Investment in Housing

To perform all these services and make a profit for its stockholders, a housing estate corporation would need to be well financed. One such corporation could manage as many as 10,000 properties of various types, sizes, and quality. At an average value of $10,000 per unit, this represents $100 million worth of residential real estate. Such a corporation would not be unlike many of the new towns now being built. This local corporation could be a subsidiary of a large holding corporation, operating over the entire country and managing, maybe, one million dwelling units or $10 billion worth of real estate. Investments of this size compare with today's corporate giants in other fields. Theoretically, sixty such holding corporations could manage the entire 60 million housing units within the United States--close to a $1,000 billion value. Questions of monopoly and interstate commerce may pose serious obstacles, but these are not insurmountable.

The local corporation, which would manage 10,000 units, would have a gross annual revenue of $12 million. This is an estimate of the annual rental value of $100 million worth of residential property--assuming that the 12 percent per year (or 1 percent per month) rule of thumb applies. The holding company for a hundred local corporations would have an annual gross revenue of $1.2 billion.

The larger the number of properties under one corporation's control--they need not be in contiguous locations but preferably should be in the same geographic area--the easier their supervision and maintenance. Size alone would give the housing estate corporation an opportunity to adjust to, if not reduce, the ups and downs of occupancy, absorb changes in rental values, and adopt planned rather than spasmodic replacement of housing as its policy. In essence, the housing estate corporation would operate individual houses or apartments as a hotel operates individual rooms or suites--a horizontal Conrad Hilton, if you please.

Continuity of Managerial Responsibility

The most important concept introduced by a housing estate corporation is continuity of managerial responsibility. As owner-investor for residential property, the local corporation would deal with the local governments supplying community services and with local companies supplying energy, water, and other utility services. The corporation would perform the function of, or contract with local professional realtors to handle the transfer, the buying, the selling, and other related management services customarily handled by real estate firms.

The way such a housing estate corporation would be organized--its size; its relationship to, and supervision by, a parent company; how many properties one management would be capable of supervising--are currently being researched. Experience in managing commercial properties will be one reliable guide, and realtors experienced in buying and selling residential properties know how many individual transactions they are able to handle in one office.

Starting a Housing Estate Corporation

A housing estate corporation could start by buying well-maintained existing properties, which would become part of its housing inventory. It could buy rundown existing properties, refurbish them, and include them in its inventory. It could then buy or lease raw land or reclaimed land and build new housing there. In short, the housing estate corporation could acquire its assets through construction, renewal, or rehabilitation of residential property. As the owner of residential property, the corporation would be responsible for payments to wholesale suppliers of the six ingredients of housing that comprise the product that the corporation retails to consumers at a profit. It would (1) pay a ground rent to suppliers of land; (2) pay property taxes to the municipality; (3) pay the suppliers for building materials or components that make up the building improvements; (4) pay the utility companies for supplying energy and other services; (5) pay interest to suppliers of capital; and (6) pay suppliers of management, insurance, title transfer, and related real estate services.

New Sources of Capital

It is conceivable that a housing estate corporation could begin with capital invested by manufacturers of building materials and equipment. Such firms today are supplying second-mortgage credit in the form of loans for the difference between the first mortgage provided by the lending institution and the equity invested by the buyer. This is one way in which manufacturers help finance their retail outlets--investing in a housing estate corporation could be another. At least 10 percent of the initial working capital of such a corporation could be raised from investors who are suppliers, like these manufacturers, and from investors who are the consumers or occupants of the corporation's housing.

Next, instead of borrowing the money necessary to buy land (which may come to as much as 20 percent of the total investment), the housing estate corporation could lease land and pay a ground rent. Or the landowner might prefer to sell and accept payment in stock in the corporation. The way in which a landowner would choose to convert his land into cash would depend on his tax situation, his investment position, and other factors.

Then the corporation could enter into a lease-back arrangement with suppliers whose building components may account for as much as 30 percent of the total investment in housing facilities, or the supplying manufacturer could retain a chattel mortgage on the equipment--which never actually becomes the housing estate corporation's legal property while it is in its care and possession--and agree to maintain and replace it periodically.

Finally, the remaining 40 percent is represented by those parts of the house that obviously are not demountable, such as foundations, walks, and driveways; this portion might be financed with mortgages on which the housing corporation would pay interest to the mortgage lender.

Rate of Return on Housing Investments

The housing estate corporation would draw its capital roughly from the following: 10 percent from stockholders investing in the corporation, 20 percent from the landowners leasing land to the corporation, 30 percent from the suppliers of replaceable equipment and materials incorporated as part of the building improvements, and 40 percent from lending institutions whose mortgages finance the fixed improvements on the property. Because of the difference in risk, the rate of return on these types of investments might be graduated: the lowest rate return would be paid on the ground rent since the landowners lien on the corporation income is second only to taxes due the community. A somewhat higher rate would be paid on the mortgages--this lien on the property comes after the landowner. A considerably higher rate of return would be paid to the manufacturers that supply material and equipment. And the highest return would go to the stockholders in the housing estate corporation. There should be two types of stocks: preferred stocks that would give resident consumers a participating ownership in the property they occupy and common stock issued to the organizing owners of the corporation in proportion to the cash or services they contribute.

Consumers pay for their housing out of income; therefore the housing estate corporation becomes a new link in the cash flow between consumer and supplier. Their payments must cover the cost of operating the property as well as servicing the investment, the cost of taxes, insurance, depreciation, maintenance, and all the expenses of owning residential property. The aggregate amount that the consumers pay is the housing estate corporation's total gross sales figure.

The Consumer's Relationship to the Corporation

The occupant pays for these same housing ingredients when he makes his monthly payments to the housing estate corporation. As the consumer, he can enter into a lifelong relationship with the housing corporation if he so desires. The consumer could first rent, then later buy, and eventually own a particular dwelling. It could be a detached, row, or cluster-type single family house or a walk-up or elevator apartment. Obviously, the more a consumer is able to pay to the corporation toward an equity, the more of his particular unit becomes his own and the more he participates in the earnings of the corporation. Dividends on the stock he owns could be (1) paid out in cash, (2) applied to reduce his monthly payment, or (3) added to his equity, which he can later convert into an annuity. In this way, he builds up his own security knowing that, in time, he will be entitled to live in a house in which he has a 100 percent equity. The consumer would also have the right to apply his equity toward a house in any other location or could sell it to a new occupant. The fact that his equity becomes his piggy bank is one of the favorable features of dealing with a housing estate corporation. The housing industry needs to envision many such features as its target. Consumers want flexibility in the location they choose, the facilities they need, and the terms they can afford.

Consumer Ownership of Supplying Corporations

Another important feature in the contract between the consumer and the housing estate corporation is that participation on the part of the consumer can be more than that of a tenant if he cares to make it so. The principle is to encourage home ownership. However, because the ownership of an individual property can be a problem in today's mobile society, flexibility in his contract agreement would greatly enhance the institution of property ownership.

The ownership of stock in a housing estate corporation would be no different from ownership of AT&T stock, for example. If he owns stock in AT&T, the individual objects less to paying a higher telephone bill. The same is true of other purchases that the consumer identifies with companies in which he owns stock. Even without such ownership, brand loyalty is a powerful sales aid. In the rental car business, for instance, people tend to prefer one company over the others even though all are trying equally hard to get his business. People also prefer stopping at the same hotel when traveling. It seems that the more mobile the consumer becomes the more he tends to establish loyalty for a particular product or service. This loyalty satisfies his need for familiarity in a changing world. Extending this need for familiarity to housing, which the individual consumer purchases repeatedly during his lifetime, there is logic in having this requirement met through the ownership of stock in a housing estate corporation.

Savings and Loan Associations in a New Function

In a way, savings and loan associations traditionally convert monthly payments made by consumers into the capital aggregations used to finance suppliers. It is conceivable that the collection of housing payments and supervision of housing property could be combined. The housing estate corporation could use the capabilities of the savings and loan association to administer individual accounts. Conversely, the savings and loan association could invest in or even become a housing estate corporation in its own right. This approach would entail legal questions, but the possibility of reviving the original purpose of building societies, which was to participate more directly in both the financing and the construction of housing, should not be dismissed. The point is that collecting recurring payments from people, who either own or rent housing that is financed by a building society, is an inescapable task. This task also faces the housing estate corporation. The consumer should have the option in accumulating his housing equity of adding to his savings account in the savings and loan association or buying stock in the housing estate corporation.

Another legal question is how much of the individual property that is controlled by the housing corporation and is subject to a mortgage held by the lending institution can, at the same time, be owned by the occupant. The occupant can have a limited title to his individual property plus a share in his housing estate, as in a condominium, which makes him not just an owner of his particular unit but a part owner of his neighbor's share in the estate as well.

The Need for New Funds for Housing

The problem of raising the initial capital to create housing has been discussed most lucidly in a recent article in the Harvard Business Review by Samuel Hayes and Leonard Harlan entitled "Real Estate as a Corporate Investment." The article presents an excellent case for manufacturers' investing in residential properties in which their products find an end use. The manufacturers' superior credit can help to stabilize the flow of capital into housing, whose feast or famine history of financing has been a chronic illness of the industry. Perry Prentice's recent Round Table on Today's Home Mortgage System brought out most forcefully the need for continuity in investment funds that are made available to the home building industry. Without this steady flow of long term funds to keep their business going, much of the exciting results of new construction technology will not find a way into the market. John Heimann, in his study for the Department of Housing and Urban Development, points to the crucial need for new sources of capital for housing if the industry is to double our housing stock by the end of this century.

Concept of the Housing Corporation Is Not New

The concept of a housing estate corporation is certainly not new; it was first suggested by Ivan Tarnovsky, some 30 years ago in his Equity Plan. What is new about the concept is the identification of the housing estate corporation as a link in our housing system, which in turn becomes a subsystem of the whole urban complex--which John Eberhard discussed as one single system in a recent article in Scientific American. In today's mobile and industrial world, the function of providing housing must be funded, managed, and performed not as an individual, but as a corporate, effort--in much the same way that we supply people with food, transportation, and all the other consumer needs that modern life calls for.

Interestingly, enough, the concept of consumers owning the corporations that supply their housing is not unlike Walter Reuther's suggestion that labor share in the ownership of the automobile companies that employ them. A famous papal encyclical many years ago also explained why the interests of employers and the interests of workers are identical. If stock ownership is good for employees, why not for consumers? Why shouldn't a consumer own stock in a corporation from which he buys products or services just as he may own stock in a corporation that employs him? If consumer participation becomes important in housing, there would be a more even flow of money from employer to consumer to supplier and back to the consumer in his function as investor or producer.

The emergence of the housing estate corporation is already evident. The only question is how fast it will come about. Organizations are being formed that will become the nuclei for a whole system of such corporations. They are nothing more than the application to housing of financial technology that is developed in other fields. If we had more time, we could discuss how all of us in this room will use our charge-a-plates to pay for our shelter and add to our housing savings account at the same time. I hope that the housing estate corporation in which you will live and the housing corporation in which you will own stock become a profitable investment for you.

DISCUSSION

SKINNER: On the subject of financing on a great scale homes for lease, would this be something that the government would have a great hand in?

WITTAUSCH: It needn't be. We have some two hundred financial institutions that have an investment in housing today.

SKINNER: Well, won't the government frown on merging? After all, General Motors was only allowed to get so large.

WITTAUSCH: Well, take one of these corporations of say $150,000,000. Is this a big company or a small company? For a town this is not much. But it's a start. And you can start to build up a network like that.

SKINNER: But the national aspect of being able to move from San Francisco to New York City and just exchange housing. It's tremendous. But still, how about financing? That large of an institution would have to have national financing, wouldn't it?

WITTAUSCH: Well, the vehicle for financing is a new financial institution. It's really nothing new that's not being done today. All we're saying is let's put it together so that it can become a viable system.

WAGNER: I think that the concept that you have here is a very solid and viable one. I hope that if this develops we will keep the federal government out as much as possible. Private industry can handle this. There's no question but that the fiasco in the housing market which we've had the last year and one-half should never happen again in the history of this country. If this becomes the instrument which can ameliorate some of the cyclical trends, I'm all for it.

QUESTION: I'm impressed with anyone's ability to assess a corporate philosophy. I don't understand how they do it. I wondered, Jack, if you'd tell us a little bit about the elements of this philosophy and how you judge whether it exists or not, and to what degree?

WAGNER: First, I could say we jump up and down three times and throw salt over our shoulders, but that really isn't the extent. I think that, number one, we have an automatic reaction set in here, once we have defined our theory. Corporate managements are very interested in this. Of course, they have become very interested in getting us to cover them. We can pretty much forecast, when we go to set down with the chief executive officer of a corporation that we will hear our words come back to us. We expect this, and discount it 100%. We go through a whole series of investigations of the chief executive officer, and interviews with him. We then go out and interview all of his officers. But more importantly, we get very heavily down in middle management and employee levels. There are outside interviews with all competition. Pretty soon, this whole pattern begins to fit. Is what the chief executive officer is saying true? Is the specific type of morale activity true within the corporation? Employees are magnificent indicators of who is doing what, when and where. Pretty soon, a nice picture begins to set in.

But believe me, if all you do is contact the chief executive officer of a company and take what he says, you're headed for a lot of trouble a lot of times. We try to do as much in-depth investigation into an operation as possible. I think that a lot of this comes from the fact that anybody who's never been on the operation side in a corporation has an extremely difficult time of trying to assess management. We make sure that the people we have on these assignments have been operating managers in corporations, large and small. When it comes to evaluating R & D activities, we have a wide range of free-lance consultants that we can pull in on this point. But I think our most important indicator is what competition says of that company.

QUESTION: How successful have these building operations been? Port Arthur for example. Have they demonstrated that they can be successful?

WITTAUSCH: Those corporations which had the initiative to stay with it are more successful than those corporations which were traditionally "build, finance and sell," and then get out. This has been the traditional way of creating a housing stock. It's unfortunate, because later on, 20 years later, the government has to come around and pick up an urban renewal program and clean up the mess. Now, we're saying that this is "a hell of a way to run a railroad."

Of all the consumer goods, nothing is more steadily consumed than housing, since everybody has to sleep somewhere every night. So, he consumes it. It really has a constant use. Therefore, it should be financed with that in mind. And when you finance it over time, those corporations who have done that, and look at it as an investment from which they will draw an income, rather than as an investment that they will run away from; it becomes a profitable thing.

QUESTION: The reason for the housing slump right now is not a lack of demand, but a lack of money at the right price. Are you saying that you're going to have economies this size or something dealing with what you've proposed? The housing market is as much of a competitor in the money market as are those industries that have been able to go ahead and borrow money.

WITTAUSCH: Yes, that's right.

QUESTION: Then you think that the building efficiencies will develop and will enable the housing market to pay more for its money?

WITTAUSCH: Take the question of maintenance. If you manage a thousand houses, and you have a painting contract to keep them good-looking; you know very well that you can get that job done per unit cost at a much lower figure than if the thousand people go to the same painter to get the job done. It becomes like painting the Brooklyn Bridge. Now the more properties that fall into this kind of a maintenance contract, the more the housing can be kept from depreciating. And by doing that, your investment becomes a better risk; and by reducing the risk, you reduce the cost of money. So this whole thing, when you look at it as a system, begins to make sense.

QUESTION: Are you saying also then that the ownership of these units would have to be in fairly close proximity? You couldn't have properties all over.

WITTAUSCH: If you think of Park Forest as one such unit; it has about five or six thousand units there, and it's under one management. That would be a logical managerial entity, I would say. And you could have 10 or 15 different Park Forests in different parts of the country; each supervised or managed by some professional manager.

QUESTION: These are going to be a physically integrated unit in terms of number of units in the same area, right?

WITTAUSCH: It would be better for the supervision. It wouldn't have to be exactly contiguous. But I think it would be good in the same area. The important thing is that you could move from Park Forest in Chicago to Park Forest in Indianapolis and transfer your equity; just like these employees that move around for large companies. Each company has its own little housing corporation.

QUESTION: You're not necessarily dependent on new technology to build these housing units themselves, right?

WITTAUSCH: That's right. But the technology that I mentioned; the systems approach to looking at housing over time, rather than in-place-costs is one of the things. Ask air-conditioning companies, what is it that you actually sell. They say air-conditioning. I say that they are actually selling comfort. And comfort is up to the consumer. He wants it to be hot when it's cold, and cold when it's hot. And he wants to know how much it costs. He doesn't care whether he burns oil or gas, electricity or atomic energy or whatnot. Just tell him what you're going to do and what it is going to cost. That means that it's got to perform. That means that service is part of it. They say, well, we're not manufacturers. We're not in the service business. I say that they don't have to do this at all. All I am saying is what the consumer's requirements are.

Now you don't have to do a thing. But if you don't, your competitor will. So, it's up to you. What we're saying is that the suppliers of housing components have a vested interest not only in selling the product, but selling what that product does, and maintaining it, and see that it follows through in its performance. As you know, Sears and others have picked this up very quickly. That's their whole approach.

HAYWOOD: May I interrupt here just to give some historical perspective to this. You made the observation that the supply of funds for housing had dried up. That has been the main cause for the price being too high. I think we need to look at what have been the sources of funds for housing in the past 30 years in this country. We've taken a certain type of financial claim, the savings account; whether in commercial banks or savings and loan associations or mutual savings banks; and we've relied upon that as the major source of funds to go into housing. We've used this financial intermediation process which dates from the early 30's, for the most part as is in its present form. It was set up to channel funds into housing in a particular way. Now, what happened in '66, in particular, was that that particular form of financial claim was priced but of the market. Savers found that they could get higher rates of return from other types of investment. So they slowed down the inflow of the savings and loans. We had a "credit crunch" begin in '66. We've been relying upon a certain system of putting funds into the housing market. Now what's been suggested here is a new system of gathering these funds from other sources where we may not face the same constraints, so far as competing for funds, in a period of "tight" money. Also, a large corporation has flexibility in funding itself over a long period of time.

COMMENT: Yes, but you get back to the same basic facts whether you're using savings or equity funds for investment. You're still competing on the rate of return. Stocks have been sold on the market recently and put into savings accounts.

HAYWOOD: The reason that housing was priced out of the market had nothing to do with the people that used housing. It was a defect in the institutional structure. The people who used the housing weren't allowed to compete, because of defects in the institutional structure. They were just as willing to pay the cost of money as General Motors or U. S. Steel or any other claimant.

COMMENT: Well, I don't think they were.

EDWARDS: Oh, yes they were. The whole problem there was the matter of structural defects in our financial system. You talk about innovation; let's take a savings and loan association, or a commercial bank for that matter. Government regulations prohibited them from innovating in the development of any new sources of funds. They could only raise funds in a certain manner. Because of last year's trouble, they now have a little more freedom to innovate.

Those of you who are on the R & D side, and have never been in financial institutions really have no idea how restrictive government regulations are on innovation. You have to do business in a way somebody decided a generation ago. Things should have been done in the preceeding generation to prevent what happened then. That's about how far behind we are.

QUESTION: Mr. Haywood, this concerns the role of financial institutions in financing the new idea, or highly based, technologically orientated industry as it is getting started. It's been said that in the Boston area the help the commercial banks have given in making fairly high risk loans to these new companies, has provided an environment that allows for a lot more spin-off than, for example, in Philadelphia, where the commercial banks are not orientated so highly toward technological industries. Would you care to comment on this as to how much this is a factor in your mind. Also, what or how do you get bankers in Philadelphia or Timbucktu to do this?

HAYWOOD: Let me take that first question. What studies I have seen on this suggest two factors that would explain spin-off from technology centers; where you've got secondardy companies being set up. One is entrepreneurship, and that's what Jack is talking about. I mean you've got to have the entrepreneur to get the thing organized and so on. The second element that's been found necessary is the presence of a banker that knows what the game is about. That is, not that he is just able to assess the risk in an abstract sense, but that he understands the process involved in whatever the undertaking is. At least he understands enough of it so that he cannot only assess the risk, but he might also be able to make some helpful suggestions to do some creative financing that fits the particular project. Now, there has not been much study in this, but what little has been done suggests that these two elements have to be in a situation before you get any significant "spin-off" from a technology center, such as the Boston area.

QUESTION: What you seem to be saying is not that the variation in risk taking differs from one part of the country to another on the part of the banker but that some are tradition bound. In Kansas City if you want to borrow risk capital on something that has four legs and moos, you're most likely to get it. In Boston it's going to be on a science-product base, and in Cleveland it's going to be a metal and transfer line. But the risk factor is the same. Doesn't that lead us then to think that we need a little bit of innovation in terms of mechanism to permit risk capital to flow regionally?

HAYWOOD: We should not forget the banker in our information dissemination programs. Consider the way some banks have consciously gone about hiring experts in various types of business in order to be able to service these industries. Agriculture is a good example, or say a very prevailing example. Many banks, in the post-war period in particular, did hire agricultural experts in order to be able to do this kind of lending in an intelligent way. There had been new demands placed on banks in terms of financial requirements. That is, making a farm loan today is no longer a 90 day note, or a demand note. You've got to make a budget loan based on the farmer's total financial requirements. This may involve financing equipment and his land, as well as his annual production. This takes an expert to sit down and figure it out. Some banks have hired experts in various kinds of industry in order to be able to do the same kind of thing.

I think it's not just a matter of moving the technology around so much as it is seeing that the banks are not forgotten in this whole technology transfer process. By bringing people in, or by taking the people you have in banking and giving them an insight into the new technology you may be able to get better financial support.

Now, let me take up the second question of why some banks are more inclined to undertake risks than others. It's a very diverse system. There are 13,500 commercial banks in this country, and it's my observation that they can make just about as much money running what I call a "low" service bank as they can running a high public service bank. That's the unfortunate situation. In many banks, we've done some things to insulate them from public pressure; quite a few things in fact to preserve a structure which includes a lot of small banks. I don't know how we can alter such a system as this. It gets into political considerations, not just considerations of economic efficiency.

The fact that in Boston they've had a better or more venturesome group of bankers than in Philadelphia; well, the only explanation that I could give there is perhaps that there is some historical accident. The tradition in the Boston area is that they are influenced by the industries that they have developed. The bankers have learned how the industries have developed, and this has induced them to be more venturesome. Whereas, in Philadelphia, the trust business has been the big thing. I wouldn't want to underestimate the responsiveness of the financial system in general. I think that a great deal more can be done.

QUESTION: I'd like to ask a question of Jack Wagner. You emphasized that in the future, for a corporation to be successful, would have to be "multi-industry" and "multi-national." Earlier in this conference, it was stated that the major innovation in space exploration did not come from the larger diverse companies, but rather from the smaller companies. And I've heard it mentioned at other times that size and extensive organization stifles creativity. Do you care to comment on this?

WAGNER: I think that I can defend the position that size has little bearing with regard to corporate creativity. It's how management sets up the tone within the corporation. While people in the operating subsidiaries may not agree on this situation, I think that ITT is one of the most active operations, in the world. There's a huge operation going. I can cite you many other huge operations that are dead. And there are people all the time out in the job market. But, I don't think it makes any difference how large or small a company is, as long as people get authority and aren't afraid to stick their necks out. Top management creates that climate and says that you do stick your neck out. This is very important.

The international area is something that I think has ramifications far beyond anything we realize at the present time. In the fall, I've been periodically conducting major conferences in New York City. I'll have one that involves the international monetary situation; the practical reality today of East-West trade, trade with the Soviet Bloc countries. And the third round of this thing will be the effectiveness of the Kennedy Round of Tariffs. This is a very interesting thing for corporations.

Over the last two months, we've had a special "task force," which has gone around interviewing government personnel, industry personnel, and others in the United States and overseas. I think we've found pretty much abysmal ignorance all the way through of what anybody was saying of any-body else. But believe me, there's going to be a significant impact. And I've seen nothing covering it, in Fortune or in any of the national press; nor have I seen knowledge, as far as I'm concerned from federal government personnel of what it really means. Some of the chief executives of large chemical companies could really let their hair down on this point.

EDWARDS: Another interesting view of this question is that some major banks in this country can join with some other banks in other countries of the world to put in some capital to provide some very innovative financing ideas generated outside of this nation. Even though we have a highly fragmented structure of financial institutions in this country, if a few institutions would try to get together in that same way here, the Comptroller of the Currency, the Department of Justice and I don't know who all would be looking down their throats tomorrow morning.

It's really difficult for a financial institution to be really innovative. It's subject to so many rules, regulations and restrictions. We probably need some studies made to find out if what we have encourages or discourages the financing of new ideas. As for example, we might be better off to have a risk taking bank in Boston and a conservative one in Philadelphia than to have a conservative one in both places. We sometimes get the idea that if we had fewer banks, they would be more imaginative.

This reminds me of some studies that we've had in the federal government that bother me. Somebody makes a study and finds out that the Army buys blankets for $10, the Navy for $12, and the Air Force for $20; and somebody gets the idea that if we just let one agency buy the blankets, they'd all buy them for $10. My reaction to that is that if we only had one, it would buy them for $25. In the financial institutions area, we're a long ways from knowing whether our system is really better or worse than one that we might have.

HAYWOOD: Let me make one comment there. I have a lot of contact with large financial institutions. They can afford to devote some of their resources to hiring imaginative people to seek these things out. One of the problems in banking for a great many years, was that routine consumed so much of the time of the managing officers from the President on down. Trying to balance the thing out each day consumed a great deal of time and effort of everybody concerned.

I read a case just the other day where a bank with just $8,000,000 had gone into computers. And over the period of a couple of years, it had improved its routine until it now does all this routine work in one hour. The Presient of the bank now has time to go around to all these conferences and tell everybody about it. Whereas, 20 years ago, he would have been back home at 6:00 trying to balance the things out. There is a release of resources here for financial institutions, and I think you're going to get a little more imagination.

QUESTION: I was interested in Mr. Haywood's break-down of the companies that had gone into computer programs in the banking industry. The big ones seem to be getting in on this, but a great many small ones can't afford the services of a service bureau. Do you have any observations on which banking systems are making these adaptations the most rapidly?

HAYWOOD: It's mainly in terms of the number of unit banks. I don't have any break-down so far as branch banks versus unit banks. But most banks under $10,000,000 are unit banks. And that's where the lack of application is.

QUESTION: I come from the most backward state in the Union, as far as banking is concerned, which is the state of Illinois. We're trying to get branch banking there, and I just wondered if new technology may help us to get it? I know that some of the small unit banks are now using some of the big downtown banks' computer systems.

EDWARDS: Indiana might even want to argue with you about Illinois being the most backward state. For example, the Indiana Department of Financial Institutions is having a public hearing to decide whether banks in Indiana should be permitted to pay more than 3½% interest on savings. We're the only state in the Union that has ceilings less than that provided by the federal government. Incidentally, about the only way a state can outdo the federal government is to make things more restrictive. They can't liberalize.

We have time for one more question if anybody has a burning one.

SKINNER: I've a real burning one for Mr. Wagner, who's "hot tip" we haven't received.

WAGNER: I'll talk to you after the meeting about that one. I'd just like to go back for a second about what happens in Boston, because I happen to have been involved in a few situations up there. You have a unique situation in the United States there. You have Harvard and M.I.T., and you have a very close relationship between Harvard, M.I.T. and most of the industry. They move back and forth, the university faculties up there like they do in France. Most of the people who work in the investment capital area, mutual funds, etc., also come from Harvard and M.I.T., and they work around the same bit too. This local people motion is quite unique.

EDWARDS: I remember reading recently that in Boston it has become the "in" thing to be involved in the new technology.

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SESSION NO. 9

THE ROLE OF RESEARCH INSTITUTES

Chairman:
Howard L. Timms
Chairman, Policy Committee, ARAC
Professor of Business Administration
Indiana University

Moderator:
James Alcott
Director, Economic Development Division
Midwest Research Institute

Panelists:
Howard R. Batchelder
Consulting Chemical Engineer
Battelle Memorial Institute

Gerald B. Bay
Manager, Technology Utilization Center
IIT Research Institute

Ralph Ely
Office of Industry Services
Research Triangle Institute

Jesse E. Hobson
Heald, Hobson and Associates

John G. Welles
Head, Industrial Economics Division
Denver Research Institute

INTRODUCTION

Dr. Timms opened the session with a statement of the theme--the role of the Research Institute in technology utilization and economic growth. He then introduced Mr. Alcott.

Mr. Alcott introduced the panelists and a different format for the session. Each panelist was given three to five minutes to comment on his Institute's program in technology transfer and economic growth. Then ten questions were discussed by the panelists. Conference discussion followed.

SUMMARY OF COMMENTS BY RALPH ELY

Mr. Ely stated that the Research Triangle Institute is one of the younger research institutes; started in the latter part of 1958 and now employing about 300 individuals. It enjoys a unique relationship with the three universities in the Research Triangle area, Duke University, The University of North Carolina, and North Carolina State University. Half of the Board of Governors of the Institute comes from the academic field, and the other half comes from industry in the area. In discussing cooperation with the universities, Mr. Ely stated that last year, about 90 faculty members actually participated on projects and were paid by the Institute for projects on which they consulted. On the other hand, about 22 or 23 of the full-time staff of the Institute are adjunct professors and teach graduate courses at the universities.

Commenting on his own job for the last two years, Mr. Ely said that the Institute became concerned, because it was not really regionally oriented. It was performing research for the United States Government and for large corporations in other parts of the country. It really had no identification with the region as far as industry was concerned. Consequently he was charged with the task of discovering ways in which the technical talents of the area; not just the institute, but of the universities and of private organizations; might be brought to bear on problems of North Carolina industry. Publicity, engineering society meetings and visits to companies in the area proved somewhat disappointing. Small companies came because it was a free service that was offered.

"I was acting as a transfer agent in this sense," Mr. Ely said. Any company that had a problem of a technical nature was invited to call or get in touch. His job was then to attempt to find a solution for these problems. Much of the time, this resulted in a call to a university professor. The help might involve a day's consulting for the company; or perhaps a few hours of laboratory work; something rather small in nature. In no case did there really result what one would call a research effort or adaptive engineering that would really be of help. Mr. Ely suggested the reason for this failure being because most of those that came were small companies that could not afford very much. What this effort has achieved is making Research Triangle more regionally oriented by letting people know of its existence and of its interest in them. With respect to large companies, Mr. Ely suggested that it is less difficult, because the contacts are usually made at higher levels. The research engineers talk directly to the engineers of the larger companies, and research efforts come through that route.

SUMMARY OF COMMENT BY JOHN WELLES

Mr. Welles identified the Denver Research Institute, founded in 1947; as an integral part of The University of Denver. Currently the Institute employs about 500 full-time staff members. Primary point of difference from any other research institute in the country was related to a very conscious effort to have close relationships with academic counterparts in the University of Denver. The heads of three divisions in the Institute are also heads of their respective academic departments. In five other divisions this is not the case. The Metallurgy Department in the College of Engineering was started by the Metallurgy Division of the Research Institute. Mr. Welles pointed out that faculty are used on projects; and Institute people teach part-time. This enables the University to offer a wider curricula than they would otherwise.

Mr. Welles also referenced the difficulty in helping regional industry as much as they would like to; although they have experienced some success, in the economic field. He pointed out that one of the difficulties that the research institute has in serving, technologically, its regional industry, is that for instance Colorado has very highly diversified, small industries. Although Denver Research Institute was set up to help service these industries with a small staff, it didn't begin to have the depth of competence needed to serve the highly diversified problems that were brought in.

A second point he emphasized was the lack of money to solve these problems. Consequently, the institute was forced to go to the federal government, and to national firms, to survive; and to build a staff which would be large enough, in turn, to serve the needs of the local industry, which was not able to support a sufficient staff with their low volume of work. As a result the Institute is now not only designed to solve problems for local industry; but also, to solve problems at the national level. Also in recent years, more interaction with the university has resulted in more basic and applied and less developmental research.

On the subject of economic development he suggested that one does not have to have as diversified capabilities to help a region in its economic development and planning. He pointed to this a major reason why the research institutes have had more impact on their local areas, in terms of economic development than they have, in many cases, in the technological areas.

SUMMARY OF COMMENT BY GERALD BAY

Mr. Bay identified IITRI as the Illinois Institute of Technology Research Institute, formerly Armour Research Foundation. IITRI was established in 1936 as an independent, not-for-profit contract research institute affiliated with the Illinois Institute of Technology. IITRI's basic objectives, as stated by Mr. Bay, are to benefit the country by performing the best possible research and development for industry or government; with special attention to the applications of scientific advancement to the needs of society.

The university and the research institute, have a common board of directors and a common president. The organizations are run somewhat independently, and very few teachers do research in the institute or vice versa. Mr. Bay suggested that this tends to avoid conflicts between educational purposes and direct service to industry and government, which sometimes can occur. Also, it gives the university people an opportunity to concentrate their efforts on education and basic research, while still providing a loose organizational tie between the groups such that interchange can still come about.

SUMMARY OF COMMENT BY HOWARD BATCHELDER

Mr. Batchelder pointed out that the Battelle Memorial Institute has no formal university ties. It was endowed by the will of Gordon Battelle and started operations in 1929. It is incorporated to work for the advancement of science through inventions and discoveries in the field of metallurgy and related subjects. It has broadened from that a good bit. It has a close informal association with Ohio State University, in particular, and with several other universities. Some staff members teach at the universities, and the Institute uses consultants from various universities around the country. But, there is no on-going formal relationship, the Institute is separate and distinct, governed by a self-perpetuating board of Trustees. There are presently four laboratories, two in the United States, one in Frankfurt, and one in Geneva. While the Institute operates within the guidelines set forth in its not-for-profit charter, it must also operate as a business organization. He indicated that there are about 3,000 people in the Columbus laboratory, and a total of about 7,000 world-wide.

Mr. Batchelder then discussed a fully owned subsidiary called Battelle Development Corporation, which develops inventions brought to it by third parties as well as those from the Institute, trying to bring these into some sort of commercial fruition. Any money that Battelle Development Corporation makes out of its efforts must come back to the Institute and apply to the furthering of the original aims under Battelle's will.

Mr. Batchelder identified Scientific Advances, Incorporated, as a profit-making subsidiary. The profit reverts to Battelle Development Corporation, and in turn reverts to the Institute. There are many cases where things that have been developed were useful, were desirable, were not made, and would not be made. Scientific Advances, Incorporated, was established to make these things. He observed that Scientific Advances, Incorporated, is free to go into joint ventures with other companies, and is free to undertake operations and invest money on their own.

On regional connotations, Mr. Batchelder pointed out that one of the conditions under which the Institute took over the laboratories of the Hanford Works at Richland, Washington (now known as the Pacific Northwest Laboratories of Battelle Memorial Institute), was that it make a specific and planned effort to use the resources of this organization to advance the economic development of the Pacific Northwest.

SUMMARY OF COMMENT BY JESSE HOBSON*

Dr. Hobson suggested that the non-profit institutes in this country were one of the first mechanisms of technology transfer. Mellon, Battelle, and Armour were concerned with the transfer of technology primarily in the chemical, physical and engineering areas, from one industry to another, and from one company to another, within customary limits regarding proprietary rights and confidential information. The function which they performed was one of transfer.

The later research institutes which appeared about the time of WW II, performed a little bit different function; but still one of transmitting technology in its broadest sense he said. They expanded from the mechanical sciences, the engineering sciences, and chemistry and physics, into economic research and the social sciences. He suggested that more recently these institutions are going into areas of public administration and political science.

Also cited was a changing relationship with universities, during this time. Mellon had almost no relationship with the University of Pittsburgh. Battelle had no relationship with Ohio State University. Armour Research Foundation had almost no relationship with Illinois Institute of Technology. There has been a much closer relationship between the new research institutes and universities. Dr. Hobson emphasized this as highly significant and in keeping with a change from very applied work to much more basic work. This highlights the research institute as attempting to bridge the gap between the basic research laboratory and the applications in industry. He cited an extreme example of this as the Graduate Research Center of the Southwest in Dallas, which is devoted almost entirely to basic research.

Dr. Hobson suggested that the invention of the non-profit research institute was a unique contribution of the United States. It has been adopted in Europe and elsewhere, but it was invented here. On the present role and function of these organizations he raised the question: is there a need for more of them? if so, what kind of institutions? or do we have enough?

His final point, concerned the development within the last few years of these research organizations as instruments of state government, for economic development of the state. Research Triangle Institute in North Carolina was started with that as one purpose. Spindletop Research in Kentucky, was essentially established by the state of Kentucky. Although it

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*Of fourteen independent not-for-profit institutes, Dr. Hobson has been very closely associated with ten and has served as Chief Executive Officer of at least three.

is not directly an agency of the state, it now has some five million dollars of state money to further the economic and social development of the state of Kentucky. Gulf South Research Institute in Louisiana was established at arm's length by the state of Louisiana, with state and private funding, but to contribute to the economic development of the state. Mississippi Research and Development Center one of the more recent ones, is an agency of the state of Mississippi; a part of the state university system. The North Star Research Institute in Minnesota was established by the Upper Mississippi Research and Development Association, primarily for the development of that region. Dr. Hobson emphasized that the new ones that have been established have been established with public responsibility, as agencies or near agencies of states or regions to further economic development.

DISCUSSION

ALCOTT: I think the need to go outside the region to survive is one reason why it was relatively easy for the research institutes to gravitate toward the federal government. Howard, would you like to comment on that?

BATCHELDER: In general, a research institute cannot subsist on the research needs of a region, and have the diversity that's required by the needs of that region. Battelle found that we could not do this on a regional basis. We found that we needed to work on a national basis. And as you get farther down this road, as you begin to diversify, to spread out into the whole panoply of research and engineering, you find that the whole resources and research needs of the United States alone are not enough. And you then find yourself in not only a national, but an international situation. You begin to proliferate until we are now working literally world-wide.

I think we are also working better within the United States, because we are working substantially in every country of the world. Also now, we have a staff size to provide the diversity for most of the things that we might be asked to do. This is an extrapolation that, unless restricted by one means or another, is a natural consequence and a natural pattern of growth. The same forces that impel you to move out of the region, also tell you to move out of the country.

ALCOTT: Jesse, what does this say about the newer institutes, which are, almost by definition local. Do you think it says that they cannot do a good job?

HOBSON: No, I don't think so. I was thinking as you were talking here, about the role of Battelle and the development of Battelle. And I know the same thing happened to Stanford Research Institute; it has become a national institution, and then international. But I think the research institutes like Spindle Top, Gulf South, Mississippi Research, Northstar, and to some extent, Research Trianble that have been established to serve their states can develop their staff to work with agencies of state government, to serve the industries in the state, and to help with the economic development of the state; to solve the social problems of the state, without necessarily becoming large, national institutions. It does mean that there will have to be some financial support from the state government or somewhere. This of course, is happening in Kentucky, Mississippi, Louisiana, and to some extent, in Minnesota. However, to develop an institution which is going to be self-sustaining from its own operations, it has to operate on a nation-wide basis, or even wider.

ALCOTT: Gerry, how does IITRI see itself in terms of regional-national split?

BAY: We, of course got our start on a regional sense. I think we had some national overtones. It grew to an international one. We do have a key role to play in the international scene, especially in developing the resources of various countries, and increasing their rate of industrialization.

ALCOTT: Ralph, your boss once took me to task for referring to R.T.I. as a regional research institute. So, I've always been leary about making any comments about the nature of your business. We'd like to hear what you have to say on it.

ELY: As Jesse pointed out, the Research Triangle Institute was considered initially as the focal point of a much larger development with the Research Triangle Park. The Research Triangle Park is a 5,000 acre piece of land that has been set aside in North Carolina to attract industrial research laboratorites. The Institute was a second thought; I won't call it an afterthought, but I'll call it a second thought; to act as a focal point. 'Here is a research institute in our Park, why don't you come join js'?

We were initially considered a regional research institute. To serve the industry of that region, cotton, tobacco, agriculture. As has already been pointed out here, in attempting to sell to industry in the area, we found ourselves spending much more time trying to get a $5,000 research contract, than was required to go to Washington and get a $50,000 or a $100,000 research contract. It's a matter of resources. An institute must be self-supporting; or in some way, receive money for the services that they render. If you want to exist and live, you have to do your selling of research in areas where you can sell. Seventy-five percent of our work is for the federal government; 25 percent is for large corporations, mostly outside the state of North Carolina.

We still have the intent and desire to work in the region. We had a regional economist that we gave, free of charge to the State to help them in their planning. This was at no cost to the government. We supported this man on our own overhead. As a result, he helped them develop proposals to the federal government for grants for studies in various regional development activities that are associated with North Carolina. Since then, he has participated as a consultant with them. But no program in the institute has developed. It was our hope that a regional development activity would come out of this. But this is just a single man who is working with the state now as a consultant, being paid with federal money from programs that are being undertaken.

I think it all boils down again, and again, to the resources that one has available. If the state government is willing to pay an institute for manpower to help them, fine. If an institute becomes large enough, such as Battelle with its development corporations, and has some income of its own that it can play with, fine. I think that is perhaps the ultimate objective of research institutes; to develop some ways of acquiring money that they can use in helping the industry and economics of the area.

ALCOTT: I think it's clear when we're talking about the research institutes, that we're talking about many different kinds of organizations; some of which bear almost no similarity to others, operationally. It would follow from this, that we all have some very different kinds of roles that we play in the technology transfer and utilization process. What's appropriate for Battelle is perhaps not at all appropriate for Denver, or for M.R.I., and vice versa. Jesse, before we get too far into that, I'd like to come back to one of the revolutionary points that you talked about, the fact that the institutes are moving more toward public problems, social problems, political problem areas. Some people say that's where the money is.

HOBSON: I'd like to put a little different slant on it. That's where the need is. That's why the institutes have moved in this direction. The institutes have moved somewhat away from the areas of the 'hard' sciences, into the areas of the 'soft' sciences; social sciences and even political sciences. State governments, particularly, and agencies of the federal government too, need the assistance of organizations of this kind, in planning and developing their programs, and in the solution of their problems. I personally think that it's very appropriate that the institutes have moved into this gap.

Now, I think this means, in many cases, there'll have to be support from a public sector for these institutions. There will have to be funds made available from state governments or from the regions someway, in order for them to exist. They can't do what Battelle did or what Stanford did in building an organization that is large enough to support themselves. There will have to be some subsidy. I think it is quite appropriate that there be some subsidy. The suggestion was made yesterday, at the luncheon talk, that maybe we ought to be finding some way to support these non-profit research institutes; from federal funds to give them some additional help in technology transfer and utilization of technology; and maybe that should be. I certainly feel that state governments, in many cases, need their assistance; and therefore, should pay for it.

ALCOTT: Howard?

BATCHELDER: I didn't intend my remark to be entirely crass. For any institution to be self-sustaining, if there is no contract, there is little basis for doing any work, except with the institution's own funds. Obviously, if more money is available for contract in a particular area, more work is going to be done in that area. And if there is an increasing amount of federal funds or state funds devoted to social, political and economic research; the research institutes are going to do more and more of this kind of work. If there is money available for metallurgical research, then there is going to be more research in this area. The whole point is that money controls the kind of work that is being done.

I think the machinery for your support, Jesse, is perfectly obvious. None of the states have any interdiction, that I know of, that would prevent them from giving a research institute a contract to do a specific piece of work. It need not be a subsidy. It can be payment for specific services rendered, and be deliberately designed to build up that institute. The projects are chosen, so that that research institute becomes what that state wants it to become. There is a tangible output, a tangible result and return from the state money that was spent. I think this is much more healthy than a subsidy.

ALCOTT: Why shouldn't the research institutes be furnishing the leadership here, instead of following the dollars? We've criticized the universities all week for not taking the leadership; we've criticized business for not taking the leadership; we've criticized the federal government all the time, because it does take the leadership. Now, where do the research institutes fit?

WELLES: I've got an ax that I'd like to grind. I hope to be very brief, and I hope that this will be very pertinent to the topic of the Conference. It seems to me that there are certain background conditions when you look at any given region around the country, that stimulate the growth, and are somewhat necessary for the growth of science and technical activities in the region; whether they be government based, industry based, or university based. First of all, there has to be a general understanding about what it takes to develop this kind of activity on the part of the community; so that they will be willing to supply the supporting facilities. Supporting facilities in the terms of a secondary school education of a quality necessary to attract good people, who have children that they want well-educated. Second you need good sites for industrial plants and research laboratories and a financial community that is willing and able to support the needs of the entrepreneur. Third, it's very helpful if you have the right attitude and awareness on the part of people engaged in these activities, so that they keep abreast of changes through acquiring new technology, new management techniques, etc. One essential aspect is if you have government, university or research institute based activities and industrial or scientific activities, you must get interaction amonst these components in your region to set off the so-called self-sustaining critical mass process of growth.

The research institutes and universities can play a vital role in helping create these background conditions, and if you create these background conditions for growth of scientific and technological activities, you have created a greater receptivity for technology transfer; the so-called 'I.Q.'--innovation quotient, that Sumner Myers was talking about the first day. Research institutes and some universities make a real attempt to interact with their community of science, and with the larger community in their region, to try to educate that community on what is going on, and what the needs are. When you do this, you do it in a variety of subtle ways. You go down and get on a committee at the Chamber of Commerce, and you try to interact with it. You try to create a situation at the top; where you can serve on boards of directors and advisory groups. You serve on a variety of committees at the state and local level. In these subtle ways, you have interacted with your community, and you raise their 'I.Q.'

You can work with political candidates. We had a situation where two of our staff, on opposite sides of the political fence, were consciously feeding the opposing Congressional candidates the same information. This generated a much broader exposure than we could ever possibly generate for these ideas that we felt were important for the region to know about. They took an active interest in it. And they made a lot of speeches on it. They were trying to out-do one another. So, I think this is a way that an institute can take a leadership role, and generate the kind of background climate that stimulates growth, technology transfer, and ultimately, business for the institute, or the universities.

ALCOTT: One of the things all these institutions, whatever their differences, have in common is quite a diverse staff in terms of the talents, and backgrounds. Everybody from Alvin Weinberg on criticizes the universities for being discipline-oriented in a mission-oriented world. This is, I would think, a constraint that the research institutes don't have. We don't have to be discipline orientated.

But, I'm wondering how much we really differ from the universities in this? Are we really as multi-disciplinary, or as mission orientated as we can be; as we ought to be? M.R.I. is set up, organizationally, along disciplinary lines. We have a Chemistry Division; a Physics Division; a Mathematics Division; an Engineering Division, etc. I think that most of the rest of the institutes are also set up that way. I'm curious as to how you become multi-disciplinary or mission orientated from an organizational point of view? Gerry is ready to tell us about IITRI.

BAY: We have taken a few steps along these lines. We are very definitely organized along disciplinary lines; and we do have the Chemistry, Electronics, etc. But, overriding each of these discipline divisions, we have centers, which are problem oriented. These are free-floating centers. They draw from the total resources of the institute towards a very definite problem or mission. Typical would be the Water Resources Center; the Law Enforcement Center, and I guess last, but not least, the Technology Utilization Center. So, I think here's a small step in becoming mission orientated.

ELY: I think in using the terms disciplinary or multi-disciplinary, it ends up being more of an attitude than anything else. True, most institutes have their Physics Departments and their Engineering Departments, etc., but, there's more of a tendency for people in a research institute to cross these disciplinary lines, than there is in a university. This is a general statement that I'm making and there's certainly exceptions to it.

I'm thinking more of the attitude of the people that are involved. In a university, which is pointed more toward basic research, there's probably not as much need to talk to people in other disciplines as there is when one is working on a problem, as he is in a research institute. Instead of talking about mission orientation, I feel more comfortable in using the more definite term of problem solving. Because this is what I think the research institutes do, they solve problems. In the university, on the other hand, the people are interested in finding all they can about a particular subject; to acquire more information about the detail of a particular subject. I think the attitude of multi-discipline approaches, or inter-disciplinary approaches is realistic in a research institute.

ALCOTT: That's a useful point. It's interesting to me that Battelle is the only institute that doesn't have research as its middle name. And I'm wondering if this is significant?

BATCHELDER: There's one point that hasn't been made. It hasn't been pointed out that all of these organizations are organized along disciplinary lines for administrative purposes. This is essential. A chemist must be in a position of reviewing the work of a chemist. And a chemist must be in the position of passing final approval on the work of a chemist before it's released. There must be a hierarchy of science or engineering in any work that we do, or the quality of the work that we do will suffer.

Concerning the problem orientation, I think this has not been stated strongly enough. This is a machinery for pulling together people from divergent disciplines, without, in any way, sacrificing the scientific and technical excellence of the work within the limits of that specific discipline. Some years ago, a man in one department of a university told me that it was easier for him to get a contract with Battelle authorized, than to get their own Physics Department to do the radiation work that he wanted done. This could not occur in a place like Midwest or Denver, or any of the rest of them. If you needed some radiation work done by a good chemist, you could get radiation work done easily and quickly. And I think this is an important part of the flexibility. When we say multi-disciplinary, I think what we mean is that we have access to people who eat lunch together; people who talk over their problems, and who talk about these problems from entirely different backgrounds, and are free to work together in any arrangement that you want.

HOBSON: This is one of the functions which the research institute can perform in close contact and cooperation with the university. It's very necessary, for obvious reasons, that a university be organized along disciplinary lines. But a research institute can approach problems, and can be problem oriented, and can afford an opportunity for faculty people and graduate students to work on these problems, contributing their own disciplinary approaches, and their skills and their competence and knowledge in their disciplines, to a problem which is of much broader scope. Frequently, it's hard to organize an approach to those problems from a university environment. This is one of the things that a research institute in close cooperation with a university can contribute. It can provide an opportunity for university people to work on these problems.

Incidentally, the other side of that coin is a very important one. The research institute needs the guidance, the expertise, the stimulation of the faculty member and the graduate student; and their close contact and concentration of their discipline. That's why I'm glad to see the closer relationships developing. I think it's a very necessary development between research institutes and universities.

WELLES: We use one other mechanism at the Denver Research Institute. When we are thinking about entering a new problem area, or just a new area of research opportunity; we form an 'ad hoc' committee. The 'ad hoc' committee may just meet once and disband and forget it, or it might meet for a year and one-half. The 'ad hoc' committee members are chosen carefully, representing the disciplines, not only within the institute, but from the university departments that bear on the problem area or the area of science and technology or social problems. It's proven to be a very good mechanism for getting people acquainted so that they can talk together about a common problem. It has produced results.

TIMMS: I was very interested yesterday, in the session in the afternoon, about the introduction of technology into the banking industry. There was a part of that story that I thought you might like to hear which wasn't told yesterday afternoon. Chuck Haywood told about the use of computers and so forth, in the banking industry. He didn't go on to say that the Bank of America, which is the largest bank in the world, introduced that technology into the banking industry. This was done through a contract with Stanford Research Institute, to develop a computer for banking purposes.

This is a real interesting story because the Bank of America went to Stanford Research Institute and asked them if they could develop a computer for banking purposes. And S.R.I. undertook that job. It was a 5 million dollar contract, which, I believe, until very recently anyway, was the largest single contract that S.R.I. had. And like many contracts, it became 7½ million before it was finished. I think it was very interesting that a very conservative industry; the banking industry in this case, had the courage to lay 5 million dollars on the line for a very risky development.

No one could promise results. True, there was a lot of technology available, but the application of it to that industry had not been made. Everybody realized that it would be necessary to develop some device for reading checks, etc. which was not available at that time. The Bank of America had not only the courage to make the investment, but the courage to stay with it over a period of several years, until there was success. We often think that there are no more conservative people than bankers, that there are no people more reluctant to take risks than bankers. In this case, that's the way the technology was introduced into the industry.

BATCHELDER: That brings up an interesting point. We're talking about the utilization of technology. And any one of us can name a dozen instances of a spectacular application of technology to benefit everybody. Undoubtedly, there were some tremendous technical brains behind most of these developments. But behind those technical brains were people with the guts to take risks; that have laid their companies on the line time and again, in order to bring this thing to real commercial fruition, and really make the advancement. I think you have to recognize that the essential ingredient in any spectacular technological advance, is always the guts of the people who put money on a risk factor that would make almost anybody shudder, when they stop to think about it. And the pay-out has been, generally, not more than the proper proportion to the risk, and quite frequently, less. Back of any technology, the willingness to take risk is essential.

HOBSON: Let me emphasize just one point. The point has just been made, clearly, that it's resources; that here's someone who has laid their money on the line. The Institute, S.R.I., could not have taken their own funds and developed this banking computer, even though they thought it was the greatest idea in the world. From somewhere must come the resources. The institutes, in general, do not have, in their own hands, such resources.

Their aggressiveness, while it may exist, is hobbled by the inability to receive sufficient support from clients, if you wish; be it state governments or otherwise, to carry out the research that we think could be done.

ALCOTT: Jesse has been talking about a fourth dimension of research institutes--the university relationship. Perhaps some of you other members of the panel would like to talk about it.

TIMMS: I would like to repeat the point that I made the other morning. I think the university has another dimension today, and that is to help in the use of knowledge as well as its generation and transmission. Most universities are recognizing this fourth dimension and trying to do something about it. In some cases, it is creating a research organization along side, or developing a mechanism like the Midwest Applied Science Corporation at Purdue. I think that actually the best environment for the non-profit research organization today is in the environment of a university.

A research institute can benefit from the university rather directly. It can help the university perform this function of the use of knowledge, the application of knowledge; as a kind of connecting link between the basic research interests and activities of the university faculty, and the need for that knowledge and it's application in industry and government.

ALCOTT: Jesse, would Stanford Research Institute have been stronger, if it had had this kind of a relationship in the early years?

HOBSON: I'm inclined to think so, yes. I'm probably as much responsible as anybody for not developing a relationship of that sort with Stanford University. And I regret it now. I think S.R.I. could have benefitted a great deal from much closer relationships with Stanford University.

Further, I think that Stanford University could have benefitted from a better relationship with S.R.I.

ALCOTT: Howard, you represent, very ably, a different view and experience here.

BATCHELDER: In our kind of work, there are some very distinct problems in the free use of professors and graduate students from a university. The work that we do is the property of our sponsors. The work we do for the government is, to a large extent, classified work. In order to use people on our staff, they have to be cleared. They have to sign agreements that turn over to our sponsors the inventions that they make. They are privy to confidential company information that I would hate to see floating around a graduate school in casual conversation. There is certainly no question that this sort of thing creates a tremendous number of problems for an organization like Battelle.

Now, we do not divorce ourselves from the university. As I told you, many of our people teach at Ohio State and other schools around there. Many of their staffs are on our lists of consultants, and we use them. We run summer training programs for selected students to give them a taste of what industrial research is like. It's very eagerly sought after. We maintain very close ties with the universities. BDC has agreements with a number of the large universities, leading to the examination and the possible commercial exploitation of inventions that their faculty members might make. So, there is a direct translation of the research that's done in the academic world into the market place, if there is a need and the possibility of transfer. We do not divorce ourselves from them. We cannot, in our present operation, integrate with them. And because of our size, we can provide the technical excellence and the technical multiplicity of the disciplines that we need to pursue our work.

ALCOTT: Ralph, as I understand it, Triangle is literally owned by the three universities. You have, by design, an intent to work closely with the universities. You mentioned that you have used some 90 faculty members. How much of your total output is accounted for by work that the university people do on projects of yours. Let's assume that your output at Triangle is 100 thousand man years. What part of that would be represented by members of the faculties?

ELY: This is a little difficult for me to come up with. Of these 90 people, I would suspect that they might have helped an average of several man days each in that year. So, we're really talking about say, 300 man days effort. Now, we have 300 people, so 300 man years times 300 people is almost a million. So it is only a small fraction. But I feel that the important thing is not these numbers, it is the attitude that is extremely valuable.

The Institute would say that the universities have been extremely important in our development. They have helped us, and we have helped them. For instance the Triangle University's Computations Center, which has an IBM 360, model 75, is owned by the three universities and the Institute. The Institute's ability to catalyze relationships between the three universities enabled the four of us to work together to acquire a very sizable computations center, which all of us are wired into.

Very recently, we have developed another cooperative effort between the three universities and ourselves which is the acquisition of a high resolution mass spectrometer; a several hundred thousand dollar instrument, which will be located on our campus, but which is being obtained under a grant, in which all four institutions participate.

No single university could have done any one of these things, nor could the institute itself. We provided, not only the catalyst, but the leadership to bring these two things into being. These are two rather specialized things. But this carries all the way down the line to the attitudes of the people.

Another important thing may be that the three schools are very different. One is an Agriculture - Engineering school; another is a Fine Arts college; and Duke is a private school with a very strong medical and research reputation, as well as an Engineering and Fine Arts School. These three schools have different attitudes. Since we have come, they have worked together much better than at any time in the past. The whole atmosphere is the thing I keep thinking of as being the way we have helped, aside from the rather specific things.

There are cases when one of these universities has been the prime contractor on a contract, and we have been a sub-contractor. There are also a number of cases that have been the other way around; cases in which we have been the prime contractor and one of the universities has been a sub-contractor

Concerning the points which Howard raises, it turns out that the projects on which we have been working are not classified, and are generally of a government nature; so we don't have to worry about proprietary information in the sense that one does with industry. The points that he raised about the difficulty of allowing certain kinds of information to get into the university structure do not arise, or have not arisen in our case as yet.

HOBSON: There's an interesting development in Philadelphia that I expect many of you know about, the University-City Science Center which is being developed there, in cooperation with nearly 20 universities. The leadership is taken by the University of Pennsylvania. There are several objectives in this science center. One is to develop a mechanism for research activities which are not particularly comfortable in the environment of a university. For example, controversy came with one of their projects in connection with warfare, which is being moved out of the university into the science center. They are developing an applied research institute. It will draw heavily in staffing, as I understand it, on the faculty of the University of Pennsylvania, Drexel, and other institutions. I think the third general objective of the Science Center is to develop a conference center, which will be used by all the universities.

ALCOTT: We talk a lot about the research institutes as such. I think it's time that we 'shift gears' and move more into the area of technology transfer and utilization.

COMMENT: May I add just one other thought that bears right on Jesse's point. I come from California. We're thinking quite seriously of establishing a Chemical Engineering Practice School Station at our institution in California, with the graduate students. And we're faced with the same proprietary problems that face Battelle. This we think we can handle. We are concerned that too many advanced degree Engineers are too research oriented and not applications oriented. Whereas the job we have to do is primarily applications oriented. We think, by establishing practice in Engineering, right in our own shop we will help to balance this out. It may be that the research institute could play a similar role for various universities.

ALCOTT: That leads into talking about ways in which the research institutes are active in the technology transfer and technology utilization process. One which Jesse has pointed out many times, is as a way station for people between university and industry or government. It flows both ways. We have a number of people who have been at the institute more than once. This, of course, is a prime means of transfer. We're all involved, formally as well as implicitly, in many technology utilization programs. Battelle, probably has an outstanding position in the country in the field of information centers. I'd be interested, Howard, in hearing a little bit about your view as to how these information centers relate to the much broader technology transfer process.

BATCHELDER: I feel more comfortable when we talk about technology utilization, because I think technology transfer has in it the purely NASA connotations of using information generated in space oriented programs, over in industrial work. Technology utilization is a broader term, and it is the function of all the research institutes in all that they do. Their job is to make use of existing or newly developed technology in order to solve problems, or approach some particular end point. Obviously, stored information is extremely important. You identify a problem, or someone identifies it for you; you outline a method of attack; you decide what it is that you're going to have to know; if it is available, you use it; if it is not available, you start programs to develop it, and hope that you're going to be successful. To this extent, the information analysis centers that we operate function very effectively, in promoting the transfer of technology from one sphere to another.

We use them for their primary purposes; things like the Defense Metals Information Center that was set up by the DOD to provide a store house of interpretative information to people with government contracts, who need information about materials of one sort or another. But, a man in our Metallurgy Department, tackling a research problem would be a 'damn fool' if he didn't run his questions past DMIC before he did anything else. This is surely just as much a part of a research operation as the traditional literature search is. This is a contribution that I think NASA has made which has gone unrecognized, and is of tremendous importance. There has been, by NASA, a determined effort to make accessible a fantastic amount of new technical information for use wherever it may be applicable. This public, highly touted and aggressive effort to make accessible and to make people aware of the accessibility of a tremendous store house of information, is one of the biggest 'spin-offs' that the space effort has produced. I don't like the word, but I used it on purpose. This is a tremendous step forward.

I don't believe that a mere store house of information is the answer to anything. The awareness that there is stored information, and a knowledge of how to assess it and a teaching of how to develop your skill at using it is a tremendous technical, scientific step forward; it is an order of magnitude above anything that we've achieved in a long time.

At Battelle, we probably run eight or ten major information centers in specific areas; the DMIC, the Radiation Effects Center, two ARPA things; the Remote Area Conflict Information Center. This is highly specialized, and of course, highly multi-disciplinary, because when you get down to considering the things that might be pertinent to remote area conflicts, you cover the waterfront and you include the water jug too. There are a number of these, and I think they function heavily and sharply in the transfer of technology. Our access to the NASA tapes adds tremendously to what we can accomplish by our own information and analysis centers.

ALCOTT: Yesterday we talked about and heard about a number of federal programs, S.I.E., the Referral Center, etc. The question that came up concerned proliferation of these. We're getting more and more libraries, more and more information centers, more referral centers. They are all an integral part of the larger scientific and technical information establishment. But the part of the question which I think was never really resolved was the relationship of these to the technological utilization process. Because of Battelle's eminent position, I thought it would be interesting to talk about this.

BATCHELDER: We call ours information and analysis centers. There's a very important difference between a store house of information and a store house of analyzed information, and a facility for analysis of information. The people that make input for our information centers are research people that do their work at the bench; that do experimental scientific and technical work. They are the means by which this material enters the information centers. Their judgment as to whether this is new, whether it is useful, whether it is in conflict with previously recorded information, and the resolution of these conflicts, is an extremely important part of the operation. When it gets past this stage, then the information specialists supervise putting it into the storage in a good form for retrieval. The analysis of what goes in, this judgment of what is stored, and the resolution of conflicts and elimination of out-dated information, so that you have a living information center and not an accumulative one, is an extremely important part of the whole thing. I think that the difficulties of maintaining this kind of an input to such an information center have been largely overlooked in the proposals to make vast repositories of indiscriminate information.

ALCOTT: This was a key point that Chuck Mullis raised the other morning on ordering of information. Gerry, IITRI has a technology utilization center, for which you have responsibility. I don't know very much about it. And I'm curious as to what goes on there, and how it would relate to some of the things Howard's talking about and to Chuck's point on the ordering of information.

BAY: What goes on in the Technology Utilization Center right now is organization. We were established the first of the year. We're just getting started in many areas. I could comment though on our relationship to our technical information research group; which is more concerned with some of the problems that Howard has brought up. This was established about 8 or 9 years ago. It is self-supporting. It does analyze and package the information; as well as perform a multitude of services for industry. I feel that this analysis phase is really quite important, as Howard has mentioned.

ALCOTT: We're developing rapidly in this country, partly by design and partly because it's just happening, quite a network to advance the utilization of technology. NASA has the RDC system to work with industry. The State Technical Services Program is working through state governments and land grant colleges, among others. The Atomic Energy Commission is changing. We heard from two of their people yesterday about how their program is evolving. We say that we people who are in the research institute business have always been in the technology transfer and technology utilization business. I'm curious as to how we fit in into this larger network, this formalized network. Where is our niche? Where can we contribute to this?

BATCHELDER: The efforts to develop mass repositories need to go to school on the difficulties that we all have encountered in our own efforts to set up specialized information centers. The difficulties, the pit-falls that lie in such an operation, should be very carefully considered when the plans are drawn for the formal federal programs, which are several orders of magnitude beyond what we're talking about. We run some big ones. But they're going to be peanuts compared to one which hopes to embrace all federal technology in perpetuity. The problems and difficulties that we found, and I use we collectively, and the solutions that have been found to those problems, should be built very carefully into any federal network that is set up. The process that the research institutes use in applying technology can be extrapolated.

We approach our problems all pretty much the same way now. We have better tools. But we run through the same analysis, and we wind up with the same procedure. You hopefully work toward a profitable and promising solution. But, it's rare that you can move from the end answer to the question. Most all of it is the problem and a solution. It's rare that any problem is solved only by the most advanced technology. A lot of the technology we use in solving very complex, very demanding, very challenging problems is technology that has been around for a good many years. It's rare that with all the technology in the world you solve a problem without creative imagination. All we do is give the mind better assistance. We don't eliminate the mind as the real means of solving the problem.

BAY: In a broader sense, one of the things we have to do first of all, is to identify what the key role, the uniqueness of the research institute is, and how it relates to some of these technology utilization and transfer problems. One thing that really hasn't been commented too much on is the word that appears in some of the research institute names. That word is independent. We don't have stockholders, and we're not dependent on a government source for our being. As such then, one of our key characteristics is that we can give independent judgments in an objective manner.

I will comment on one specific thing that our technology utilization center is doing. We're evaluating technology. That is, using this independent concept, we feel that we can take a look at some of the technology that is being reported. We're working quite closely with NASA. We've evaluated over 6,000 NASA Flash Sheets, and have made recommendations to them as to their potential novelty and significance to industry.

ALCOTT: John, you're shaking your head no. And you and your associates have studied this whole situation about as well as anyone. I would like to hear a little bit from you about your views on the role of the research institute.

WELLES: The research institutes can do a minimum of two things. They can help, let the rest of the country understand what this so-called information network is. And there's a real job to be done in understanding how the present one works before we try to change it and develop a national system. We have our hands full in knowing how to tap the existing network. It's a minority of our own staff people who know how to tap the existing systems for what they can give them. We have an educational function to perform in trying to help others to learn how to tap the existing system. What part we play within the formal system, I don't think we really know yet.

ELY: The North Carolina Board of Science and Technology, which is a state supported group; is responsible for the NASA regional dissemination center there. They're about a quarter of a mile from the institute. The Offices of the State Technical Service Program is conducted by the North Carolina State University at Raleigh, through their industrial extension service. The Board of Science and Technology has about six engineers that have accomplished the effort for NASA. That is, going out and trying to interest industry in utilizing NASA technology. The OSTS program has about eight engineers. Four of these are field engineers. And in the past year and one-half, they have visited 1,000 companies in the state of North Carolina to tell them about the OSTS program. Each of these two groups; are aware of each other's existence, and informally invite each other to various affairs; but do not really work together very strongly.

The Board of Science and Technology has a tape center, where all the NASA information is on tape. They work rather independently of the University, which uses its own library facilities as an information center.

When we were just establishing the Board of Science and Technology, I had a part in writing the proposal. I felt at that time, that the research institutes could perform an invaluable function in NASA technology transfer. This is true also of the OSTS programs, or of any of these aggressive programs; the institutes could provide adaptive engineering. You don't just take the information from any of the information centers and hand it to a man and say here it is. There must be some adaptation. The adaptive engineering to take the knowledge and try to apply it to a particular problem that an industry may have has not come about.

The reason that it hasn't is because of the kinds of companies that one is dealing with. I divide them into two kinds of companies; large companies and small companies; not on the basis of size or sales, but on the basis of whether they have a research staff or don't have a research staff. If they have a research staff, then the information center itself is almost sufficient for them. The small companies are those that don't have their own research staff, and live, by and large, on a day-by-day problem facing basis. They have to have their hands held very strongly during any time when one is trying to transfer technology into the organization. We get back to the old story of who pays for the time of an engineer? The little companies don't seem to want to do it, inspite of the fact that it's their life's blood to have new information come in.

ALCOTT: I'd like to get some people in the audience, who can speak and/or ask some very interesting questions at this point.

QUESTION: I'm from Wisconsin, and am part of the OSTS program. I'd like to ask a couple of questions to follow up Ralph's remarks. Consider the smaller companies where we see a lot of strong need for the transfer of something. I don't think it will be necessary for us to talk about space-age materials. Let's take the unglamorous areas. I see a need for this in a lot of our smaller companies in Wisconsin. It's not being very well done. Two things have occurred to me in hearing the remarks of the panel, which affect me as I try to steer our companies into using services like this. One has been often true apparently in the experience of most of the institutes; going out of state has been more glamorous than doing something local. Second, there seems to be some aura about the non-profit institute, as being something better than the private consultant, no matter how sizable. That makes it a little easier to sell. If I were trying to steer this operation in Wisconsin; how would we take advantage of obvious psychological reasons of why people do these things. Or is there some way that we can redirect our efforts to do something different? What I'm essentially asking is, why is it that people are more willing to go out of state to contract for these services? Would it be better for us to set up a non-profit institute in Wisconsin?

ALCOTT: The first question is why do people like to go out of the state? I think there's the obvious matter of stage distance. A lot of people just like to have the excuse to go to Palo Alto and spend some time for awhile. But I think part of our point may have been confused. In our case, and in many cases, we had to go out for business, because it simply wasn't there for us or anybody else. It was an economic thing. John, what's your view?

WELLES: If we had all of the research and development at the Research Institute in Denver that was contracted for by in-state firms, anywhere in the world; we could probably support a group of no larger than 10 or 12 scientists and engineers. They do go out of state. And I think that they go out of state because number one; there's very often the best competence out of state; secondly, ignorance of what we have to offer; thirdly, mistakenly or maybe correctly, unpleasant experiences with us in the past, or with other educational institutions in the state. I think that these, perhaps, are some of the reasons. You'll always have, as Ralph indicated, the feeling that if you go out of state, you're going to get somebody better than somebody in your backyard. You just can't lick that one. It's always going to be with us.

ALCOTT: Jesse, what about this business of more research institutes. Do we need more? I know a lot of people ask you that.

HOBSON: I really don't know the answer to that question. I'm inclined to think that we really don't need many more institutions of this kind in the country. I doubt if they can be supported. I doubt if there's enough activity to develop a critical mass, if we expect them to be self-supporting. I think we've got just about as many as we need.

On the other hand, in a situation like Wisconsin, or Kentucky, for example, there may be good reason to start a research organization, and have it subsidized, in part, by the state to work on problems peculiar to that state; and to develop a research organization with particular competence to work with agencies of the state government, working on the development of the state, and planning for the state. Maybe there's room for some more organizations of that kind. But concerning a general 'job' shop, the organization which is attempting to develop competence across the board, and attemptin to support itself on its activities; I'm inclined to think that we've got about as many institutions as we need in that area.

ALCOTT: Dick Carpenter had his hand up.

CARPENTER: I'd like to get back to this question of whether the research institutes could interact more with the private sector, and give the panel a little opportunity to extricate themselves from what seems to be a position of a technological 'camp follower.' Now, let me phrase the question this way so that we can see how they might devote more of their energies and internally manageable resources towards what John Welles pointed out as a very attractive activity. Can you give me more than an obvious explanation for the fact that Arthur D. Little, a profit making research institute, has about 30% of its revenue from the government, and 70% from private sectors; whereas the research institutes are quite the opposite, deriving 70% from the government and 30% from the private sector. What are some of the more subtle reasons?

ALCOTT: One reason, clearly, is that ADL is seeing this is where the money is. They have moved into management consulting much more than I think most of the institutes have chosen to do. Until we make that policy decision, we're going to be up against this rather large federal ratio of our business.

Battelle probably has the lowest ratio of federal business, of the larger institutes at any rate, so it would be useful to hear your views on this Howard.

BATCHELDER: When you mention ADL's volume, they are dealing in a field of research that is different, and is much more attractive to corporate management than scientific and technical research. There is not, and if I offend anybody's company or anybody here, excuse me in advance, but there is not, generally, within a corporation, an empire devoted to corporate management. Management consultation is something that is traditionally contracted outside the company. If you take the top 500 U. S. firms, there is in every one of them an empire, a vested interest devoted to technical research and development. They are not anxious to admit even tacitly that work can be better done in another laboratory than their own. They have spent, in many cases, tens of millions of dollars on technical research and development capability. Especially in the medium-sized ones, there is a tendency on the part of the corporate management to believe that if you have 20 million dollars in a laboratory, then there ought not to be a problem that you can't solve better than anybody in the world.

This is one of the reasons why industrial money for research is not as freely available as government money is. The government must contract it's research. It doesn't have the facilities to do it. The industries, in every case, have invested large amounts of money in the facilities, the capabilities and the staff. They have large budgets. This year, what? Between seven and eight billion dollars of corporate money on research; 300 million of it, contracted. That is one of the reasons.

One of the steps by which a wider use of research institutes occur and a wider transfer of technology can come about would be that a large proportion of the industrial research budget be devoted to contracted work, rather than to 'in-house' work. You'll find a good many research departments to whom this idea is an anathema.

But there is never a question about management consultation. Arthur D. Little may just as well be up here on the table. The fact that they are profit-making, and pay an income tax, which is the real critical determination, doesn't change them from Battelle or M.R.I. or any of the rest of them. They belong here just as thoroughly as anybody else. I don't think that the distinctions that you are drawing are really between a profit-making contract research organization and a not-for-profit contract research organization. They are between an operation that gets into business ventures and does management consultation as contrasted to technical and scientific research and development.

I would like to take this occasion to disagree with Jesse about the number of research institutes. When you look at this ratio of 300 million to seven billion dollars, a small change in corporate attitude, with respect to contract research, would make room for a whole new generation of self-supporting contract research organizations. And I believe it would be a healthy thing.

COMMENT: I'd like to direct my comment to the gentleman from Wisconsin on whether Wisconsin should establish a non-profit research organization. I represent the state of Connecticut. From what I gathered from this discussion, it is a sound investment for the state to put money into a non-profit research institute. What you have inferred at least, is that once the institute is established, the state doesn't have sufficient funds to support the research programs that you're interested in. Consequently, you have to go out of the state.

Our approach in Connecticut was a little different. We looked at what various states had done, and we came to some conclusions. One is that we have a multi-disciplinary research competence. The next is that the state does have problems that are oriented to research. From there, we go to: it's a sound investment for the state to invest in research, if you can direct your resources at problems that are of significance to the state, without creating another mechanism that is competing with existing mechanisms. What's needed is to get this multi-disciplinary apporach via the dangling of the dollar in front of these people. And this is the approach that we've used. It hasn't been completely successful, because it's very difficult to get multi-institutional participation.

QUESTION: Do you expect this institution to become self-supporting? Or do you expect to continue to subsidize it in some way?

ANSWER: Well, it isn't an institution. It's nothing except the state government with a research commission with the inducement of state funds.

BATCHELDER: So why shouldn't you go to M.R.I. with the problems you have and pay them to solve them for you?

ANSWER: We could. But the argument against that is, why should we go to M.R.I.? We've got the resources in the state. Let's direct our state resources at these problems.

QUESTION: Your university experiment station to me is almost like Mr. Ely's Triangle Research. They do a great deal of research for the small companies in the state. For example, Penn State has a very extensive program.

ELY: How much of that is supported by the company itself, and how much by the university facilities?

ANSWER: I don't know the ratio. I do know that the company has to put up some money. How much I don't know.

QUESTION: I was very interested in John Welles' model in creating an environment for interaction between the industry, government and the university. Here we relate the university and the research institute to being similar. If he hadn't put this model up, I certainly would have asked him to expound further on how do you create this interaction. I'd like to pursue that a little farther. Assume that his model is valid. Then the question is, how do you encourage the staff of the research institute or the faculty of the university to undertake these subtle kinds of activity that he referred to; to interact with local government and industry by acting on Chambers of Commerce Boards of Directors, etc.?

WELLES: This is an extremely difficult problem. You first have to have somebody at the university or the research institute, and the higher up the better, who wants this to happen. Secondly, when you add people, you make a conscious effort to get people who have not only the technical qualifications that you need, but who also have the desire to try to bridge this gap between the university or the research community and the rest of the community. Third, you needle them. You don't bring everybody on with the idea, is he an interactor. But you should bring on enough people with that in mind so that it takes place. Then, some of the rest follows from that.

These kinds of people will be drawn to the kinds of problems that require interaction; and they, in turn, will bring others into the interacting process. Then, frankly, you set up opportunities to interact through conferences, through trying to get industry people on advisory committees at the university or the research institute, locally, so they'll sit down at the same table and get to know each other.

It's been said that the competition that the AEC held for the National Accelerator Laboratory had a lot of good impact on the areas that were losers. We were one of the six finalists, and we lost out. We had people sitting down at the table who didn't even know of the existence of each other; from the business world, from the state and local government, and the university, and the government laboratories. This helps break down the barriers of distrust. These barriers, I think, are extremely real.

I think that here at Indiana one reason that the Business College has done as well as it has, is because Art Weimer has interacted with the businesses in Indiana; and is on Boards of Directors. He knows these people. And the same applies to Engineering schools in interaction. It is a 'chicken and egg' situation. Those engineering schools that are intereacting with regional and national industry are also those Engineering schools where the faculty and the Dean are well-known by industry and vice-versa. It's the nature of the people that gets the snowball rolling.

ELY: I think the crux of what John said, was really back at the beginning. He said there has to be someone that wants it to happen. This can be the president of the organization. But then, there has to be somebody that does it. This is where there has to be a spark of fire, a leadership, one man. Behind any organization, there has to be a man with a dream. And once you've gotten him, you've got it solved, because he won't fold; he'll find the ways to do it. It's an individual sort of thing.

HOBSON: I think you've touched on one of the most important functions of the non-profit research institute: to make it want to happen. This is something that the research institute can do. In this triangle here of government, state and federal, university and industry; I think the research institute can play this role of interpreting the problem and finding people who want to work on it, and want something to happen.

QUESTION: My question is to the whole panel. What is the dream of the research institutes about 'T.U.' What is 'T.U.'?

ELY: My dream, which I mentioned just briefly in the beginning, which came about when I was participating in the writing of the proposal, both for STS and for NASA was that the Institute would do the adaptive engineering. Now, maybe this isn't extensive enough, or it isn't a big enough dream; but it was something that was extremely definite, finite, and could be identified.

HOBSON: You mentioned that the percentage of government support for non-profit research institutes is very high. I'm not sure this is a bad thing, because the non-profit research institutes working for government can perform a very useful function in the utilization of that technology which is developed, and with which they become familiar on government work. For example, in the early days of S.R.I., we started an antenna research laboratory. This laboratory was equipped with federal money. The support came entirely from the federal government. But it wasn't very long after we were working on antenna research that we found that commercial companies should be interested. We got commercial companies interested. As I remember, some five or six years later, fully 50% of that laboratory support came from private industry. This was, I think, a direct translation of technology developed in government work into private industry. That's a sort of a function that the research institute can perform.

ALCOTT: Gerry, you must have been doing some dreaming in the organizational stages of your center; or are they all still nightmares?

BAY: I'd say, in regard to the dream, that mine is I want to try and couple the vast resources that we have, in a technological sense, into solving social problems. I think that this is where we institutes can perform a very vital role.

BATCHELDER: I think we make the greatest contribution by being what we've been. And I don't mean that to sound unchangable. We make our living by perceiving problems and applying available knowledge to the solution of those problems. The greater the resources of knowledge that come from the federal programs that are accessible to us, the more successfully we can solve these problems.

The transfer is not traceable; it is not direct. You can't say that because of NASA's work on this or that we have a new glockenspeil over here. But, the science and technology that the NASA people learned and transferred to the technical community, is then coupled with imagination, and a new glockenspeil comes out. This is a transfer. If you're talking about traceable transfers, then I think it's a rough way to go. I believe that we perform our greatest function by being aware of what is here; using our imagination and our resources, and trying to see other ways in which that particular material can be applied to a useful purpose.

QUESTION: What 'spin-off' has occurred as a result of efforts of non-profit research organizations? From research conducted by private, non-profit organizations, what new industries have been created?

ALCOTT: The most notable is, of course, Xerox. The examples classically given are the wire recording business, and magenetic tape, at Armour, the xerography process from Battelle; S.R.I. has given us a lot of things.

BATCHELDER: There are dozens that you'll never hear of, and never realize that they came out of research institutes, because the research was confidential. Copperwell Steel Company puts out a clad cable forming steel wire, that is the result of a research program. We're allowed to talk about that one. But, we've got 50 that we're not allowed to talk about. And also about 50 that our sponsors would love to say that they dreamed up on their own, except that they know that our work contributed. You can't begin to cite most of the ones that have come out of the major research and development activities. Most of these are incremental. They are not cataclysmic events. They are step-by-step building up; xerography is the product of about 15 years of continuous and intensive research.

COMMENT: I would like to say 'amen' to a number of things that were just said, perhaps in a different context. You will recall that Congressman Roush admonished us to glamorize technology utilization. Of course, we know some of the reasons. We all have to live with the Congress. And especially the 'T.U.' people at NASA; they have to live very closely with the Congress to get funds. The Congress, of course, has to respond to the people. And the people just don't react to anything but what is glamorous; it's a communication problem.

For instance, of the contributions that ARAC has made in the way of technology transfer and utilization; I'd say that 99.9% have been the incremental type. I would also add that most of them are 'damn' difficult to trace. This makes it very difficult for us to give the NASA 'T.U.' Office the kind of information; particularly glamorous information that Representative Roush is telling us is needed, if we're to get the public behind the Congress, and the Congress behind the Executive Programs.

I've gone 'round and 'round with NASA Headquarters on this over a 4½ year period about how to measure technology transfers. They are really mostly the transfer of knowledge components. And then when you come back to the fellow to whom you transferred them, after his project has come to significant fruition so he could give you some feed-back; he can't even remember. It's mingled with so many other components, whose sources he can't remember either. The feed-back problem, the communications problem, and thus, a justification problem is a very, very difficult one. Rather than go circuitously around it and find some trumped up method and putting 'Mini' skirts on it, we really ought to head into it for what it really is and inform the public of the true nature of it, as I think has come out here today.

<u>WELLES</u>: That's along the lines of my dream on technology utilization. People not only react to what's glamorous, but I think they also react to what they feel is important. It seems to me that the Denver Research Institute is a tiny little frog in a huge pond. If we want to sit back and figure out how can we have the greatest impact on technology utilization; granted, number one, we want to do our little frog job right and the best we can. But second, we need to contribute generally to the rest of the pond's attempt to transfer and translate technology by creating background conditions of understanding of the importance of how it works, of a general awareness of the opportunities that are going untapped. This can be a function of the research institute.

<u>QUESTION</u>: Dr. Hobson, you mentioned earlier about the problem of the critical mass of size for a research organization. The gentleman from Connecticut mentioned that they're obviously trying to avoid getting into this problem of critical mass. This is something we've been quite concerned with in Wyoming. How can we mobilize the talent that is there, and do it in the least expensive way without setting up a physical facility. Based on you gentlemen's experience, is there some way you can set up an organization with a minimum amount of facility, as such, that serves to handle this thing, and do it in a relatively glamorous way? You've got to have a focal point. You've got to have somebody who has his fingers on who is where within the state or within the region that can perform these things. Does there seem to be a place in the research environment, in a teacher environment, that would enable a very small organization to do, in effect, what the research institutes are doing?

HOBSON: I think Mississippi has tried to do this. It is an interesting approach. Mississippi has created a small organization, supported with state funds. The intent is, that this small organization will draw on the talents of the universities and other people in the state of Mississippi, to work on the problems of the state; for agencies of the state and for private industry too. I don't know whether this is the most efficient way to do it or not; but I think this is a very interesting approach. This is a little bit like the Connecticut approach. They have created in Mississippi, in effect, a state agency to do this.

ALCOTT: It's a development corporation, and not a research entity.

COMMENT: Jim, I think one thing possibly overlooked in the transfer of technology is a lack of technology to transfer. Maybe this is the place where the independent research institutes should be in touch with university faculties.

BATCHELDER: We do basic research with our own funds, in fields where we think it should be done, and where our people have interests. But this is not necessarily limited. The amount of money that Battelle can spend on this is small in relation to the amount of money that we spend for other people. But we do invest quite a bit of money in what we consider either early applied, or basic applied research, because it is work that we think should be done.

QUESTION: It is interesting to note one vital link that I see from a corporation standpoint, that seems to be alluded to many times by Ralph and Dick. From my perspective, it seems of vital consequence where the individual corporations fit into this picture? What can we use, and how can we become aware; or to use your word, have awareness and interaction. That awareness and interaction somehow has to tie back in with profit, profit for private commercial industry. If you fail to make that distinction; then all the technology is never going to be useful. It has to be profitable to use to be profitable to you, for us to recognize your need and to come to you for the assistance that is so obvious.

The national government, I feel, has a perspective that private industry does not have sufficient knowledge of the vital need of technology in the overall growth of all companies; from North American on down to the smallest machine shops. So you are lacking, in your discussion here today, a contact within private industry, a person within that company, who has intimate knowledge of the long-range plans of the company; or the lack of long-range plans; the scientific and technical competence of that company; and also an awareness of the research institutes, the sources of information that are available through technology utilization, etc.

This is a very important folly, which I recognized at North American as being a direct result of the NASA technology utilization program. Without that, I wouldn't be in this position. We wouldn't have responsible people actively trying to glean technology. And the collection of the technology is not, at this point, the key factor. We need, within many industries, this key point of contact between yourselves and private industry, which you don't have right now. You are having to develop these creative applications, and that is the person or persons with whom you must come in contact and communicate with. We must encourage the companies to have that responsibility within them.

ALCOTT: I wish you had asked that question an hour ago, because I think we all would like to have an opportunity to answer that, but lunch is now ready.

HOBSON: He's right that the research institutes should be doing exactly that.

BATCHELDER: There are companies that have men within the company to search for problems, and then to search the technical 'universe' for the best capabilities for the solution of those problems. They invest money in having people who look for problems that can be solved better outside. Then they (these men) become their 'window' on the outside world.

END OF SESSION

LUNCHEON SPEAKER

John E. Duberg
Assistant Director
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A GLIMPSE OF LANGLEY RESEARCH CENTER'S FIFTY YEARS OF SERVICE TO THE NATION

by

John E. Duberg

Langley Research Center will, this October, celebrate its fiftieth anniversary and has chosen for the theme at its celebration the phrase, "50 Years of Service to the Nation." Langley began operation in 1917 and for more than 20 years served as the only Government civilian laboratory in support of aeronautical research. It was the operating arm of the former National Advisory Committee for Aeronautics, which committee was composed of leading representatives from Government, industry, and the universities who were interested in the advancement of flight. In those early days the principal problems were aerodynamic and as such the Center became the site for most of the Nation's wind tunnels, especially those of high speed and large size which were regarded then as too expensive to be constructed and supported by any private group. Still in active use is the Full Scale Tunnel, built at a cost of $1 million and dedicated in 1931. At that time it was the largest; it has a test section 30 feet by 60 feet. Today it is still useful in investigating the "low-speed" handling characteristics of modern aircraft during take-off and landing--particularly V/STOL aircraft, and of similar characteristics of so-called lifting bodies which are being proposed for vehicles reentering the atmosphere from space flight, which vehicles will have some control over the actual site at which they will land.

The format of an industry-university-Government team that was developed during these early years was credited with the successful prosecution of American aviation, which in the private transport section dominated the world and in military aircraft established an industrial base and aircraft that dominated the skies in the final phases of World War II.

World War II had a most significant effect on the NACA for it occasioned the expansion of Langley itself and spawned off from Langley two new research centers, one in Ohio--the Lewis Research Center--to pursue engine research and one in California--the Ames Research Center--to support with aerodynamic competence and facilities the aviation industry which had gravitated to southern California.

The laboratory at Langley Field increased in size from a pre-war maximum of several hundred to a post-war maximum of about 3400. With the exception of propulsion activity, for which the Lewis Research Center was established, all the disciplines that entered into the design, construction, and operation of aircraft were supported in depth. Aerodynamic research, which was dominant in the earliest days, was now accompanied by research programs in aircraft loads both in flight and in landing, and aircraft structures and applied materials. Subcommittees of the main committee in all of these disciplines, through frequent meetings, maintained liaison between those persons active in Government, industry, and the universities.

Throughout this period of history and to the end of World War II the individual research projects could be characterized as small, relatively inexpensive, and the disciplines of aerodynamics, construction, propulsion, and operations were comparatively independent. This state of affairs came to an end when aircraft research moved into the area of supersonic flight, and it was proposed that a research aircraft especially designed to enter this regime of flight be built. With funding and procurement provided by the military and research support from NACA during its construction and flight testing, the research airplane program was initiated and a new Flight Research Center at Muroc Lake, California, was established. The X-1 penetrated the sound barrier in 1947 and the age of supersonic flight was here. Other specialized research aircraft were built under the joint military-NACA team concept. The currently flying X-15 represents the latest aircraft in this series, and is now providing a test bed for the exploration of problems of high-temperature structures and ramjet engines in the range of Mach number 6 to 8.

The advent of the space age in 1957 resulted in the subsequent incorporation of the Langley Research Center and the rest of NACA into the National Aeronautics and Space Administration, established in October 1958. Two important consequences flowed from this action. First, the scope of the research activity increased but, since much of the same basic technology underlays the construction and operation of aircraft and spacecraft, it was for many research people only a reorientation of their efforts. The new dimension of space did give rise to additional laboratory facilities for the simulation of the space environments. In particular, vacuum facilities expanded and associated with them are various sources for producing both electromagnetic radiation and energetic nuclear particles. Accelerators have been built which can produce macroscopic meteoritic particles. This period also corresponded to the expansion of the computer facilities, not only as an aid to mathematical analysis but as the active control link in various simulations of the manned control of aerospace flight. Such tasks have been simulated as flying supersonic transports in commercial operations into New York's Kennedy Airport, the guiding of Gemini and Apollo vehicles into rendezvous and docking with other spacecraft, and the landing of the Lunar Module on the lunar surface.

But the most significant change which occurred under NASA was that the agency has the authority and the funds to procure hardware systems for space exploration and to fund substantial efforts in research and development activities with non-profit and university researchers. The Center, which under NACA had a budget supporting in-house activity at a level of tens of millions of dollars per year, now under NASA has developed an integrated internal and external research and development program approximating $200 million per year. Its laboratory complex is now approaching a value of $300 million.

From this assemblage of capacities, what has been and is now the role of the Langley Research Center in major national programs?

Firstly, it has conceived the specialized laboratory base required to explore problems within its mission. This was originally limited to aeronautics but now covers the entire field of aerospace. It has exploited these facilities in prosecuting a coordinated research program centered on specific missions.

On the basis of knowledge obtained, it has established in a preliminary way the basic feasibility of a major mission. Through competitive procurement contracts with industry, the store of knowledge developed and the preliminary feasibility have been incorporated into design studies in depth to establish on a more firm base the producibility of the system. Such studies usually indicate which areas of knowledge need further study and which areas may be unprofitable to emphasize. Such contracts as these may be let by Langley or they may be let by other agencies for which responsibility for final execution of mission may be appropriate.

Finally, a contract is let with industry for the execution of the actual project.

An example of a major project for which this series of efforts is in its final stages of execution is the supersonic transport. Basic research for this type aircraft was started in the early 1950's and continues to this day. On the basis of this knowledge, study contracts were let by LRC in 1962 with two aircraft firms for the study in depth of a number of possible designs. These studies were finished and indicated the more profitable directions in which to proceed toward the design of the final vehicle. Subsequent studies by these firms were carried out for the FAA with LRC personnel involved in the evaluations. Recently the president released funds to permit the Federal Aviation Administration to procure two prototypes to be produced by Boeing with engines supplied by General Electric. Approximately 75 Langley Research Center scientists and engineers involved in the original research efforts assisted the FAA in the evaluations of the proposals for the contract for which the funds have been made available.

Research studies which have proceeded for many years but for which there is no approved project have concentrated on the problems of a Manned Orbiting Research Laboratory. Such studies have proceeded through the industry study phases, but have not in the competition for project selection found sufficient reasons for actual construction.

A system being studied in the research phase and for which there is still a need for more ground-based facilities is the hypersonic cruise vehicle intended for commercial transport in the speed range beyond that of the proposed supersonic airplane. The aerodynamic propulsion and structural problems for such a hypersonic vehicle to fly at about 5000 mph are now under intensive study, just as were the problems of the SST 10 to 15 years ago.

It has been previously stated that the NASA program was a combined effort of Government, industry, and universities and the question can be asked: where do the universities fit into the Langley Research Center effort;

particularly in the large-scale efforts that have just been described for the advanced aerospace systems. For such programs their supporting efforts have been for the most part confined to the research phase and have tended to be relatively smaller than that which was experienced during the early days of aviation. This is an unfortunate tendency and the reason can readily be found in the fact that experimental facilities for significant research in these areas have become so expensive to build and operate that they are beyond the reach of even a major educational institution.

More direct and significant relationships can be and have been more readily established with those university scientists who are interested in space physics. In these instances responsibility for the scientific experiment and its instrumentation have been given such individuals. Vehicle construction, integration, and launch operations have been accomplished by industry through projects under the general management of Langley Research Center. Injun-Explorer, a joint effort of the University of Iowa, Langley, and industrial contractors, is an example of such a space project whose purpose is to correlate solar activity and the concentration of elementary nuclear particles in space near earth.

Langley Research Center is presently using all available degrees of freedom to maintain a continuing association of the academic community with our research activity. More than 100 of our young subprofessionals from 20 colleges are in a cooperative work-study arrangement which, on a part-time basis, leads to a bachelor's degree in 5 years. On a more advanced level is our graduate educational program, the greater part of which is carried on with the educational institutions in our region; in particular among Virginia institutions, the College of William and Mary, University of Virginia, Virginia Polytechnic Institute, and more recently the Medical College of Virginia. Strong contributors among the out-of-state institutions are George Washington University and North Carolina State University at Raleigh. Almost 500 of our younger employees are enrolled in these educational programs and this June 52 master's degrees and 17 doctor's degrees were conferred on participants of the program. There is a continual flow of these students and their professors between the universities and the Center for class work and advising on theses, the research for which constitutes a part of our in-house research program.

As our part of a NASA-wide program in collaboration with the American Society for Engineering Education, 37 professors are now at the Center engaged in a research and educational program which places them at the forefront of research activity and which forms the basis for an extended series of seminars and lectures to which are invited persons of national significance in the various scientific and technical disciplines.

This year, for the first time, there has been included in the group five professors from graduate schools of business administration. They have been assigned study projects in the areas of research administration and have organized for themselves a seminar series in management in which interested members of the Center staff have also cooperated.

On a world-wide basis we have been able to bring to the Center distinguished academic scientists for a year or more active participation in research. This has been accomplished through a NASA grant with the National Academy of Sciences, who are the administrators of the program.

The most ambitious venture in which we are engaged that relates to an expansion of our relationships to the academic community is our support of the Virginia Assoicated Research Center. This new Center (called VARC) can serve not only the community in which we are located but the entire state of Virginia.

The Virginia Associated Research Center is a joint venture of the College of William and Mary, the University of Virginia, Virginia Polytechnic Institute, and the Medical College of Virginia. It began when Langley Research Center proposed that one of its new laboratories, the Space Radiation Effects Laboratory, called SREL, be managed and operated by these educational institutions. The laboratory, built at a cost of $15 million, includes two electron accelerators and a 600-Mev synchrocyclotron for the production of energetic protons. It has been so constructed and equipped that it can study the effects of the radiations in space on both spacecraft components and on biological specimens as well. The laboratory is also well suited to the study of the basic physics of intermediate energy particles. It has been agreed that the useful time of the laboratory would be shared equally between research programs deriving from the institutions themselves and such programs as would be developed by investigators of the Langley Research Center. Funding for the basic operation of the laboratory and its equipment is provided by a $2 million a year contract with VARC. Additional funding for specific experiments has been obtained by grants which the university investigators have obtained from other sources. The Langley Research Center experiments have been funded by the in-house budget.

In consequence of the agreement on the use of SREL and the further commitment from LRC that all of the research facilities at the Center could be made available for graduate educational research in other disciplines, the state of Virginia has further agreed to construct for the VARC organization a graduate educational center. Most fortunately, over 1000 acres of undeveloped land was available within short commuting distance from LRC. On 100 acres of this site was built the Space Radiation Effects Laboratory. The Federal Government, through the Department of Health, Education, and Welfare, granted to the state an adjacent area of 350 acres on which has proceeded the construction of the first building of the VARC complex. The SREL has now been operating for 2 years; a high energy physics research program is under way among the state institutions. The Medical College of Virginia has started and is expanding a research program in radiobiology. This fall a faculty of seven professors of several engineering disciplines will be in residence at VARC. They are organizing a curriculum that should attract a substantial fraction of LRC graduate students to form a nucleus of their student body. It is anticipated that this faculty will also ask NASA for support of an engineering research program which will make use of LRC experimental facilities.

This year a further development has occurred which could have important economic consequences for the Langley community. The City of Newport News, in which the site is located, recognizing the availability of approximately 600 acres of undeveloped land adjacent to the VARC-SREL site, formed a committee of influential citizens to investigate the possibility of procuring the land as the site on which to establish an industrial research and development center. That committee has since submitted its recommendations to the city, which was that the basic ingredients of a successful R & D center existed and that the city should procure the land. The key factor without which success could not be expected was the existence, through the VARC organization, of a graduate degree-granting educational opportunity nearby. The city council has accepted the recommendation. The General Services Administration has been so informed and negotiations are proceeding for the terms for the purchase of the land.

The economic survey submitted as part of the committee's investigation indicated that ultimately firms employing in excess of 4000 persons could be attracted to such an R & D center. These figures did not include the personnel on the adjacent VARC-SREL site which at the present time already exceeds 100 persons. This group has designed and is expecting funding for the construction of its second building to house the engineering staff and is planning to request of the State legislature in the next biennium design funds for a third. It would appear that a new venture has been launched in our community, the ultimate value of which is as yet only imagined.

As one looks forward to a second 50 years of existence of the Langley Research Center it would seem clear that it, as well as other such centers, which are a source of original thought, can be a significant national resource for stimulation of economic growth.

SESSION NO. 10

THE ROLE OF BUSINESS FIRMS

Chairman:
Oscar L. Dunn
Vice President, General Electric Company

Moderator:
Joseph DiSalvo
Director, Aerospace Research Applications Center

Panelists:
Robert L. Adams
Vice President, Esterline Angus Instrument Co., Inc.

David H. Fax, Technical Assistant to the Vice President
Westinghouse Electric Corporation

R. A. Gaiser
Vice President, Research and Product Development
Ball Brothers Research Corporation

G. H. Stempel
Research Center Administrator
General Tire & Rubber Co.

John A. Swartout
Director of Technology
Union Carbide Corporation

SUMMARY OF INTRODUCTORY REMARKS BY OSCAR DUNN

Mr. Dunn opened the session with the suggestion that any discussion of economic growth must necessarily involve the activities of the business community. He observed that economic growth and business activities are inseparable; that the rate of growth is dependent on the rate at which technology can be converted to goods and services. American industrys' record is very good. But, he said the challenge now is to improve the process in the face of vastly greater complexities, resulting from almost limitless choices, coupled with an accelerated pace of change.

Mr. Dunn reemphasized the point made by the economists that the elapsed time between the inception of new scientific ideas and their emergence in the form of useful products is steadily decreasing. For example, the principle of photography was known for over a century before the first camera was produced. It required 56 years to develop the telephone, but only 13 years to develop the commercial use of atomic power; 5 years for the transistor, and 3 years for the laser. He said that the so-called invention industry now rivals the automobile industry in size. In other words, government and privately financed research, development and testing comprise one of the biggest industries in our society.

He used Federal government budget figures to emphasize how fast this invention industry is growing. The 15 billion dollars expended by the federal government in 1966, was double the outlay of 1960, triple the amount of 1958, and 15 times greater than that in 1950. This vast technological complex has been one of the main underpinnings of the remarkable economic expansion we have enjoyed.

However, he cautioned that the sheer proliferation of technology is imposing some serious limitations on industry's continued ability to absorb and to use new knowledge. One authority estimates that the growth rate of knowledge in the world's libraries is 2 million bits per second. The human mind can only absorb 100 bits of new knowledge per second. He said this gap is created to a large extent by the computer and new high-speed communications equipment. It is to the improved uses of such pieces of equipment that we must hopefully look for help. He emphasized the progress being made in this area citing speed increases of 1,000 to 1, and use cost decreases of 100 to 1 in computers.

The point is business managers haven't changed their own "circuitry" very much during this time. He admonished managers to do a better job of tuning in on some of the new developments in the future, to get the most out of them. In some technologically complex areas, the computer has already helped enormously in the developments of markets faster than had been thought possible. For example, he cited nuclear energy. In 1960, nuclear energy experts estimated that the year 1966 would bring orders for 1,350 megawatts of new nuclear power capacity. Actual orders booked in 1966 were 12 times greater than the estimate made just 6 years prior. Using computers, the industry was able to come up with advanced plants, designs, and fuels. It became clear that nuclear energy had indeed become competitive. He suggested that such breakthroughs need to become a common experience, if we are to cope effectively with the great demands of the future.

Mr. Dunn concluded that on every side, we have only begun the task of using new technology. In our troubled cities, in raising the quality of life, the problem is not a dearth of ideas and designs, but a lack of new and imaginative ways to employ them. If we were to look at the task of a technologically orientated business 50 years ago, we might say that it was to build a better mousetrap, or to design a better piece of machinery. He suggested that the task confronting us now is to design solutions to our problems, which will make the most effective use of machines and techniques that we already have.

He then turned the session over to the moderator, Dr. Joseph DiSalvo, who presided during the remainder of the session.

AEROSPACE RESEARCH APPLICATIONS CENTER CONFERENCE

by

R. A. Gaiser

I am no authority on overall technology utilization, but I am happy to relate to you the importance my company places on technology utilization programs such as ARAC which has contributed profitably in the commercial side of our company as well as in our aerospace division.

It is quite possible that the diversity of our company and the way it is organized, particularly with regard to R & D, make programs of the ARAC type productive ones. We are engaged in glass container manufacturing; -- rubber parts manufacturing; -- non-ferrous metal alloying, rolling, and fabricating operations; -- plastics extruding, injection molding, plating, and decorating operations; -- metal photoengraving plate and photoengraving chemical operations; -- metal decorating operations; -- and research and development operations, which in my opinion are set up to utilize available technology, possibly to a greater degree than many industrial companies.

The research and development organization is a separate corporation, responsible as a profit center, with autonomy to research, develop, engineer, sell and/or license its output, and this includes products as well as services. Our research organization is divided into two groups; an aerospace group and a commercial group. As the name implies, the aerospace group is occupied with research and development for government agencies connected with the space program. One example of its activity is the Orbiting Solar Observatory satellite which it builds as prime contractor to NASA. The commercial group is responsible for the development of commercial products as well as research for the parent company which is a good customer of the research company.

The key words here are sell and/or license its output. Developments from innovations within the research corporation are first offered to the parent corporation who may or may not wish to exploit them. If the parent corporation is not interested, the research corporation has freedom to sell or license or market. This type of organization has worked out very well for us. We started about ten years ago with three people and now have

1200 people, and it is one of the most profitable of all of our divisions or subsidiaries. In my opinion, this type organization is better equipped to utilize available technologies than the normally organized industrial research groups.

Obviously, starting with three people ten years ago has not allowed us to build up an extensive library, but ARAC has certainly been a superior substitute. Not only has it given us availability to a wealth of technological information, but it has also given us what one might think of as the services of a staff of professional searchers.

You get just about what you put into anything, and I suspect because of our situation we probably put more effort into the ARAC program than one would consider normal. First of all, we appointed as coordinator, a graduate chemical engineer who has been with the company for a number of years and who had managerial experience in several of our divisions. He was given the responsibility to coordinate the transfer of technological information throughout the entire company. He reports to a top officer in the company, and the work he is doing is producing rewards. I would like to stress this step because I feel confident, to get adequate dissemination of available technology, a person who has some stature in the company and who knows the company and its needs intimately is essential. I am confident that our librarian, who is a good one, could not do the job we are getting done simply because she does not know the detailed problem areas. Our ARAC coordinator has as his main function, primary staff and management responsibility among which is licensing. These activities keep him aware of company problems as well as opportunities. He is spending over 10% of his time in the acquisition and dissemination of technological information.

He has interviewed and questioned our first and second line people and from these interviews, as well as from visitations by ARAC people to our facilities and consultation with them, established the need for ten interest centers which encompass the activities of our company. Fourteen profiles applicable to the ten interest centers are active. Requests to ARAC and distribution of information received from ARAC are made by the coordinator. As selective disseminations, industrial applications reports, the results of retrospective searches, and other technological data are received, the coordinator notes their contents and establishes the distribution list. Each report is duplicated in full for the individuals who are to receive the information and each report is marked with a distribution list so the individual receiving it is aware of who else in the organization is obtaining that information. This stimulates the "peer to ear approach." As mentioned by Dr. Myers Monday, this sounds like a lot of work, and it is, but to get the most out of the program it is our feeling that something along these lines is required.

During the past four years, and rounding these numbers off, 80 retrospective searches have been made on subjects of interest to us. From these retrospective searches, 2000 technical citations were sent to us and from the 2000 citations, 200 requests were made for full information.

Two hundred twenty thousand abstracts were searched for their relevance to the interest centers on file for our company. Out of these, 30,000 abstracts were sent to us and from those abstracts, 3000 hard copies of reports were distributed.

We have also obtained 500 marketing abstracts from which 100 full articles have been ordered and received.

In addition, 116 computer program abstracts have been analyzed from which 19 computer programs have been ordered for use.

From the industrial applications services, 4800 flash sheet application reports and NASA technical briefs have been received from which 1000 complete hard print copies have been requested by the key individuals to whom these were distributed. It is interesting to find that these reports are requested by our people in such large numbers.

I can't give you a dollar figure, nor does time permit a complete description of the benefits we have received from programs of this sort. They are significant. Examples of importance would have to include a method of electronic circuit board assembly through the use of a special fixture which was cited in a NASA technical brief. By adapting this, our assembly time has been cut in half.

An example of a library search for a solution to a specific problem would have to include a search made for us concerning films on glass surfaces, interface cohesion of thin films, and the adhesion of polymers to silicate glasses. The resulting citations, and the reports we requested from them, and the resulting innovations are going to put stronger glass bottles into the hands of the consumer.

An example of the benefits from citations connected with selective dissemination service would have to include our interest center on graphic arts. A technique for the elimination of solids from photoresist solutions and a reference to improving corrosion resistance on zinc plating by the addition of other metallic ions has not only reduced costs of one of our graphic arts products, but it has also significantly improved its quality and the quality of print you will read.

Our aerospace division has made extensive use of ARAC services as you can well imagine; and I could spend the rest of the afternoon telling you of the benefits that have accrued here. A continuously updated bibliography on trajectory and attitude control information is invaluable to our guidance and control people. One of the computer programs received from ARAC will be responsible for the thermal design analysis of three telescopes to go on the ATM or Apollo Telescope Mount.

One last example is in bearing lubrication technology. We have been deeply involved in this subject ever since the days when we had to discover for ourselves how to lubricate bearings and slip rings for satellite operation in the vacuum of space. The selective dissemination service of ARAC in this interest center keeps us almost instantly aware of what is being done in this technology, and has been responsible for our continuing leadership in this field. Innovations occurring in the utilization of this technology are finding their way into industrial markets.

As you can see, we are very much sold on information retrieval and the dissemination of technological information by coordinating agencies such as ARAC, and I might add here--those people who state the space program is not paying off technologically have, in my opinion, not thoroughly studied the record. Technological information is not going to flow in a beneficial manner, nor is it going to be utilized efficiently unless a concerted effort is made to obtain, disseminate, and particularly to organize for the use of that information. We feel we have made a start in this direction.

SUMMARY OF REMARKS BY JOHN SWARTOUT

Mr. Swartout introduced his remarks as a look at a modern, major U. S. corporation, where it stands today, and how it got there; particularly with respect to the question of what role technology plays in its growth, and where the technology came from. The corporation today is one of the major corporations in the world, one of the largest of the so-called chemical companies. Its sales, world-wide, amount to close to 3 billion dollars. It has 12 divisions and in the United States owns some 60 subsidiaries. Throughout the world, it has plants in almost every country of the world; certainly many of the newly developed countries in Africa; and some of the less well developed countries in South America. Although it is classified as a chemical company, less than half of its sales come from chemicals and plastics. The rest come from a variety of other things.

In a comment on diversity, he identified diversity as the trend in most corporations. Major corporations are all branching out into other fields. The chemistry industry now includes many companies, which by name, would not be classified as chemical--the Chicago Northwestern Railroad, for instance. In addition to chemicals and plastics, which still is their major business; Mr. Swartout identified nonferrous, more exotic alloys for corrosion and high temperature resistance, gases which are used by NASA; liquid oxygen, hydrogen, etc., carbon and graphite in many forms, various fibers, synthetic gems, emeralds, rubies, sapphires, for both industry and jewelry, agricultural chemicals, pharmaceuticals and radio pharmaceuticals. In addition to this variety, they are also the largest of the contractors to the Atomic Energy Commission. Mr. Swartout suggested this has given them an insight to the problem of technology transfer from both sides. That is, the transfer of government technology from both sides; the generating side and the receiving side.

He then posed the question: how did this corporation get where it is today? It's a "middle-aged" corporation a little over 50 years old. It started really as a holding company; a combination of 3 or 4 companies which had common interests; one made calcium carbide; another made acetylene from this and distributed it for welding and lighting; and one which made primarily carbon for electrodes, which tied into the calcium carbide business. Mr. Swartout then discussed the company's growth from this point. Since it produced acetylene it began to wonder what you can do with acetylene? It subscribed to a Fellowship at the Mellon Institute which was assigned to a young organic chemist, named George Kern. After a couple of years' work, he reported to the management of Carbide, and outlined all the interesting things that could be done with acetylene, as far as making organic chemicals. After he finished, he said, "This is interesting, but here's a better one." What can be done with ethylene; and ethylene can be made from natural gas much more cheaply than the acetylene process. This was the beginning of the whole petrochemical industry. He then referred to the morning session where the reaction, when the question was asked, what has come from the non-profit research institutes; was Xerox and xerography. But he said this is small compared with the petro-chemical industry, which originated, really, at Mellon Institute.

He observed that this is true of all technology. Carbide was a small company then. It had very little research of its own. It decided the only way to get into research was to have somebody else do it. So, somebody took the gamble, which was mentioned this morning, and put up a small amount of money; small in terms of what's involved today, but it was a lot of money for a small, struggling company, and supported a Fellowship at Mellon. They have continued Fellowships at Mellon for some 52 years or so. Nothing quite as spectacular has happened since, but it has been a profitable activity. In the years following that the companies developed their own research. (The corporation consisted of many independent companies.) Each one developed its own research and development laboratory.

He emphasized that the technology came from basic research. The chemistry of petro chemicals is textbook, organic chemistry. The problem was to make something practical of it. The basis was the work that had been done decades before in the universities of Germany, Europe, and the United States. The problem was in translating this. This was what started at Mellon, followed through primarily by the companies' engineers, and continues today. From this has come a steady stream of plastics, silicone chemistry, etc.

In addition the corporation has grown by acquisition of technology. That is, by purchase of technology through purchase of companies. A number of companies, all of which in some way fit into the over-all pattern have been added. Despite the diversity of the corporation, there's an overlap in each case. One part or one division contributes to the progress of another. Other areas have been out-growths of existing areas.

Mr. Swartout then turned his attention to the newest division. The Electronics Division of Carbide became involved in the electronics business through several channels. First, they found it necessary to develop some of their own instruments. Some of these turned out to be generally useful to industry or technology as a whole, and they decided to market them. Also, Carbide produces metals and plastics having a very high dielectric constant, which lead to the manufacture of capacitors. They also have solid state physics programs and experience in ceramics, which lead to the manufacture of transistors. To supplement this, they entered the laser business by acquiring a small laser firm. The cumulative result of these activities is a good sized electronics firm.

In reviewing their sources of technology he emphasized their reliance on "in-house" development and engineering. Today they place almost entire reliance on "in-house" research, development, and engineering. Second now is their reliance on university research. Third, they still rely on acquisitions. But, he said, in a large corporation, you soon find that you can't do everything. There are plenty of ideas and insufficient money. The problem really is to pick out the one you want to spend the money on; the one that you think you can make the most money from. That's not an easy job. It takes a thorough understanding of the capabilities of the corporation, and the capabilities of the people you have.

Concerning "spin-off" from the government, Mr. Swartout concluded that for the truly chemical industry, the "spin-off" has been minor. For the rest of their business - the non-chemical - there's no question of the usefulness of technology, there's no question that it will become increasingly significant as time goes on. He stated the problem for consideration is to take advantage of this technology.

SUMMARY OF REMARKS BY ROBERT ADAMS

Mr. Adams identified the size of his company as 8 million dollars gross, the smallest represented on the panel. He established his intent as to outline what a growth-orientated, small company, has done to utilize technology to assist in its growth objectives. Four major areas were discussed; how they incorporated technology utilization in the company long-range plan; how they organized technology utilization within the company; some of the results obtained; and suggestions based on their own limited experience.

Concerning incorporating technology utilization into the company long-range plan, he said that about 5 or 6 years ago, the founders of Esterline Angus sold out to a private holding company. They, subsequently, brought in new management when the founders retired. The new management was assigned a growth and profit objective. They analyzed the company resources, and competitive strengths and weaknesses. The most promising market areas to maximize their strengths, and minimize their weaknesses were then determined. New customer needs were then identified; needs that were not satisfied by present products on the market. Having defined the customer needs for the next generation of products; then, they sought some new technology to help fill those needs with a new product. In this effort Mr. Adams stated that ARAC, and other similar sources, had been very valuable. In fact, it's been worth its weight in gold.

Having thus identified an unsatisfied customer need and located some new technology that promises to help fill that need; Mr. Adams said that they tackled the remaining "90% of blood, sweat and tears to develop new products with superior performance, at a competitive price, with an adequate profit margin."

He then discussed how they have organized technological utilization at Esterline Angus. They have some 350 employees, with some 47 in engineering. About 20 of these are professional engineers with degrees. Three of these professionals, which is a fair percentage of their technical resources, are assigned full-time to finding new technology. These are capable people with advanced training, whose sole responsibility is to find technology that will yield a competitive advantage. Basically he said they have spelled out, as specifically as possible, what products they hope to put on the market 3 years from now. Also they determined ones they're shooting for in 5 years, which will obsolete the ones to be invented in 3 years; and the one they're shooting for in 10 years which they hope will obsolete them both. This group reports directly to the Vice-President of Engineering.

Mr. Adams then focused his attention on the results they have experienced within this framework. Esterline Angus has grown some 2½ times in sales and in profits in 5 years. Their profits have, fortunately, been a little better than the average for their industry. One-third of this growth has been in improving the old products. Two-thirds of this growth has been from new products, developed from new technology. He referenced the difficulty of pointing to some specifically coming from ARAC, but stated that the influence is there even if not clearly defined.

Mr. Adams then turned his attention to including suggestions resulting from this experience, a little more than 3½ years working with ARAC. The suggestions were related to improving technology utilization for economic growth; with the target being for economic growth; more jobs and more profits. Unsatisfied customer needs are limited only by our creative ability to define them he suggested. On the other hand, there exists an almost unlimited source of technology; ARAC, private foundations, many other sources; that we just pick at the edges of utilizing. Between these Mr. Adams placed "the 'three musketeers' of free enterprise - an entreprenuer, risk capital, and good business management." These are the mechanisms which his company feels can get the job done. He suggested that the Midwest has not done a very good job of bringing together these 3 resources to perform the match between unsatisfied customer needs and technology. He stated personal feeling that the reason lies in the lack of a catalyst. The unsatisfied customer needs and technological resources exist in the Midwest. Free enterprise, entrepreneurs, and risk capital are all present. But it's not generating new jobs, profits, and all that goes with this. As a potential catalyst he suggested "ARAC," "B-RAK," "C-RAK:" "C-RAK" - Customer Research Applications Center, "B-RAK" - Business Research Applications Center and ARAC technology Research Applications Center.

THE ROLE OF BUSINESS FIRMS IN TECHNOLOGY SEARCH AND UTILIZATION

By

David D. Fax

The experiments which government agencies, particularly NASA, have been carrying out for the past four years in the hot-house cultivation of Technology Transfer are truly impressive, and it goes without saying that it is in the long-term self-interest of every sector of the economy, not least the industrial sector, to cooperate to the fullest in the performance of those experiments. But I wish to emphasize that these <u>are</u> experiments--they are a multi-pronged attack through a diversity of techniques to accelerate the awareness, evaluation, and adoption of new technological elements across organizational boundaries and, like all experiments, some will succeed better than others and some may indeed fail.

I have taken as my role today what might be considered an unpopular one--especially in this audience--that of sounding a note of caution, namely that there is an underlying danger of setting our expectations too high and then having the whole program suffer because those too-high expectations cannot be realized.

In the accumulating literature on the subject of Technology Transfer, a long list of potential barriers to transfer has been identified. I want to take a few minutes to highlight two of these barriers, and I choose these two because I think they are the toughest to overcome.

The first is: Given a technological development with high potential for transfer, there is still a very large expenditure of time and resources required to move that idea from technical feasibility to economic feasibility, or even (less often recognized) from economic feasibility in one environment to economic feasibility in another one.

By way of example, it was called to our attention at Tuesday evening's panel that the cost of delivering one pound of dehydrated food to astronauts in earth orbit is about $75,000. Now I know nothing about dehydration processes, but I'm willing to guess that a process that has been optimized under the constraint of a delivery cost of $75 K/lb will look totally unlike one that has been optimized for a more mundane delivery cost, though the underlying thermodynamic theory is no different.

I need hardly belabor the astronomical effort that went into the development of economic nuclear power long after the technical feasibility had been well established, or even the work that lay between the development of naval nuclear propulsion, on the one hand, and the achievement of central station utility plants on the other.

A less dramatic example: tremendous progress has been made in the joining of metals previously thought unjoinable, as everyone knows. For the most part, these newly developed joining methods require considerable special tooling and carefully controlled environments. Even where these can be readily achieved in a commercial production facility, the question must still be asked whether the joint will have to be unmade and remade in the field, where the special tooling or environment or skills are not economically available--and if so, then back to the laboratory.

These points are all obvious, but they need resaying--the effective transfer of technology can be an expensive business, and expensive investments must be justifiable in economic terms.

And now to my second point--that of identifying an item with transfer potential, in the first place. I'd like to introduce this point with a little homily, drawn from a field closely related to that of Technology Transfer, the field of information retrieval:

Suppose one has a data base containing 40,000 items (for example, documents) of which 20 are relevant to a particular inquiry, and suppose further that the combination of indexing system and search strategy is such that the probability of recognizing a relevant item is 0.95, while the probability of rejecting an irrelevant item is 0.99. It follows that the response to the inquiry will contain

$$
\begin{array}{lclcl}
0.95 & \times & 20 & = & 19 \text{ relevant items} \\
0.01 & \times & 39{,}980 & = & \underline{400} \text{ irrelevant items} \\
 & & & & 419 \text{ total items}
\end{array}
$$

The relevance of the response then is 19/419 = 0.045, or the trash ratio is 0.955.

Now this example is a bit contrived, I admit. It refers to a single-stage simple-minded retrieval system. The reason why ARAC's responses to its subscribers generally have a much higher relevance is that ARAC interposes a second stage between the computer and the subscriber, a screening of the output by people who, while not as discriminating as the original querier, can exercise better judgment than can the computer. But it is not too contrived -- one of our engineers sent a query to a wholesaler of bibliographic searches and received in return a thick book of abstracts which had so little relevance to his question that he insisted he must have been sent the wrong book. This is not an uncommon experience.

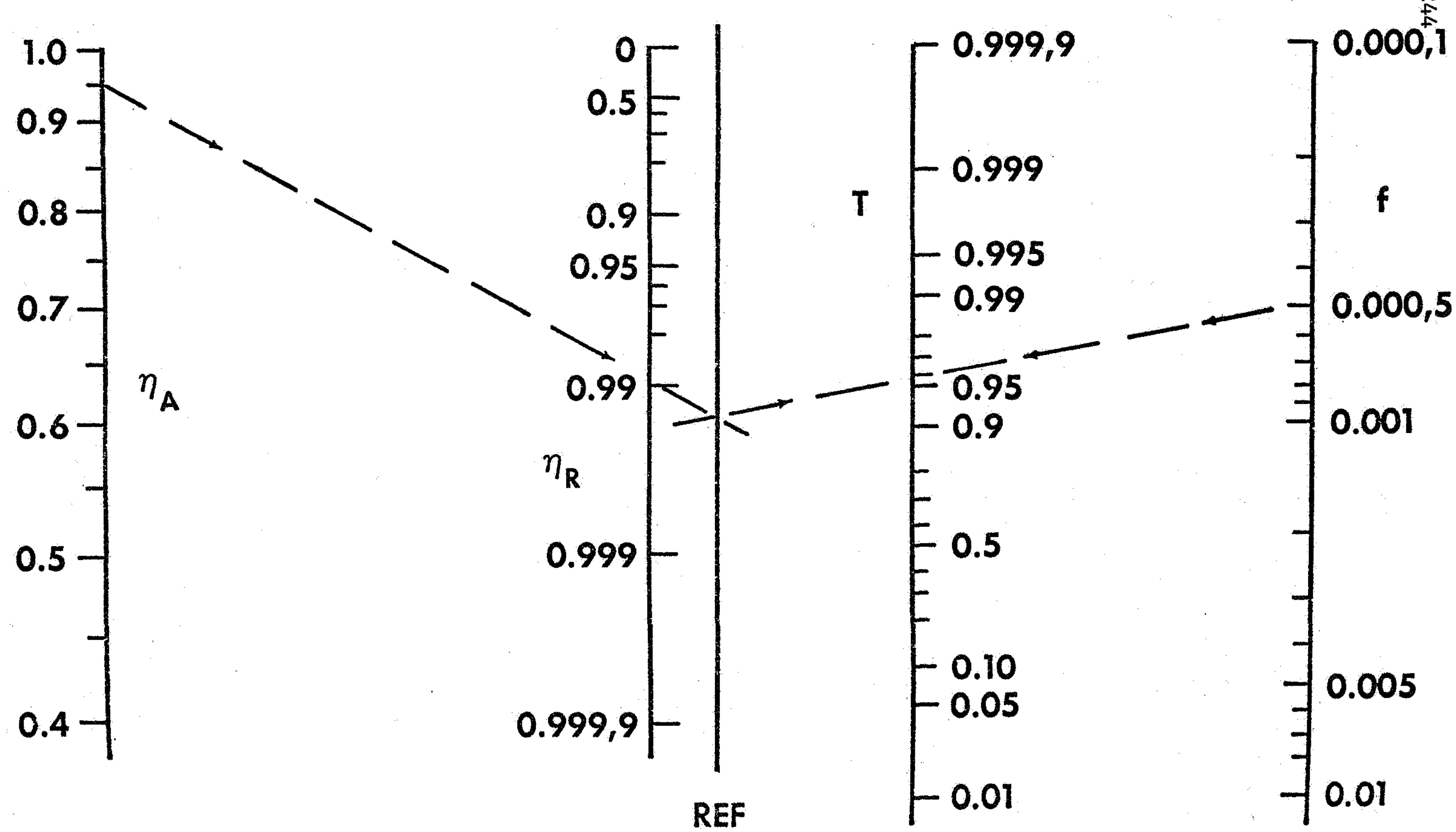
Should you object to the probabilities I chose in the numerical example and wish to try other values, the nomograph on the next page provides the opportunity. Connect the proper point on the scale at the far left, the efficiency or probability of recognizing a relevant item, with a point selected on the second scale, the efficiency of rejecting irrelevant items. Next, connect the projection of those two points on the "reference" line with the point on the "f" scale, the fraction of the data base that is relevant to the query. The intersection of the line so drawn with the "T" scale gives the trash ratio in the response. The dashed line on the nomograph illustrates the numerical example previously given. Incidentally, to properly describe the current NASA collection of documents, the "f" scale should probably be extended two more decades in the direction of smaller numbers.

Now the point of the homily is this: let the data base be, not documents, but items of new technology, and let the relevant fraction be those that are valid candidates for application to a particular problem in a particular economic environment. An industrial executive whose search strategy is comparable to that shown on the slide will not long survive to try again. So, taking into account the large development investments required, as emphasized in my first point, he gets more critical and, in order to improve the relevance of his decision, his rejection screen (η_R) goes up to 0.999 or even 0.9999. (One might, in effect, draw an arrowhead parallel to the η_R scale pointing downward and label it the "burnt child.") If that were all that happened in this process, it would be to the good, but unfortunately it is an empiric fact that as η_R gets tighter, η_A will tend to move to lower values (an arrowhead pointing downward adjacent to the η_A scale could very well be labeled "cynic"), and while the trash ratio may not suffer much thereby, nuggets of real gold will indeed get discarded with the chaff. Recognizing this in advance, there is no point, as advocates of Technology Transfer, of our getting needlessly frustrated over this phenomenon which is bound to happen.

The nomograph also includes the case where there is no screening at all of the data base, where $\eta_R = 0$. This is equivalent to saying to a querier, "Here is our whole library, find what you want."

Indeed, in efforts to accelerate the awareness step in the process of Technology Transfer, there is a strong temptation to do just this, and some experiments in Technology Transfer have characteristics which resemble this strategy. These must indeed be quite frustrating to the potential customer. The point I am trying to make here was made much better in a recent

ARITHMETIC OF INFORMATION RETRIEVAL



η_A = Effc'y of recognizing relevant items
η_R = Effc'y of rejecting irrelevant items
f = Fraction of data base that is relevant

report by the Ad Hoc Committee on Principles of Research-Engineering Interaction of the National Academy of Sciences. That group did intensive studies of ten accomplishments in the recent history of materials science and technology. The Committee reported, among other things,

> "This (data) seems to substantiate the simile of research as a well of knowledge from which engineering can drink to satisfy defined needs, rather than as a geyser which floods the engineer with solutions to present problems and with clear opportunities for exploitation."

So at the risk of giving unsolicited advice to the experimenters in Technology Transfer, I would say that we need fewer geysers and smarter ways of learning how to drink from the well of research. But I would also like to offer some consolation -- there is no need to be apologetic when pressed for more and more dramatic examples of Technology Transfer. Fellows, it's tough!

In the same sense, there is no apology needed when industry says that its role is to be intelligently selective in investing its resources; unwise investments do not come out of the hides of the stockholders alone, but eventually out of the whole body economic.

In conclusion, there is really no question in my mind but that industry can and must take a more aggressive role in the translation of space-developed technology into economic practicality. Today, however, I chose to sound this note of caution in the hopes of stimulating constructive discussion.

THE MISSING LINK: R&D TO PRODUCTION AND SALES

by

Guido H. Stempel

Full utilization of technology must have as its goal economic growth through both the discovery of new products and services useful to mankind and the improvement of existing products and services. To achieve this goal in our economy it is, of course, mandatory to transfer to production, and thence to sales, as much as possible of the technological accumulation of R&D, whether it be technology developed by R&D through their own work, or external information coming to the attention of R&D personnel during the course of their work. Only in this way can this technology be useful. It is this transfer from R&D to production, too often the missing link, which I wish to discuss briefly.

The importance of successful transfer is emphasized by the very nature of R&D. The expectancy of success in R&D projects is variously estimated in the neighborhood of five to fifteen per cent. If the promising projects as they appear are not carefully nurtured and carried to the fruition of production and sales, then R&D can become a costly luxury which business cannot afford. I do not wish to imply that all data from projects not commercially successful are useless. Far from it. But any given company can afford to pay for only a limited amount of such data. I am reminded of the young man in a small mid-western town who just couldn't quite make the grade. To keep him occupied and help him retain his self respect, the city fathers invented the job of keeping the cannon in the town park looking nice. He attacked his job energetically and no other town had as beautiful, shiny a cannon in its park. After a few months he appeared at the council meeting to tender his resignation. "But, John," he was asked, "what are you going to do?" "Oh," he replied, "I am going in business for myself." "That's wonderful, John. And what kind of business are you considering?" "Well, you see, I have so thoroughly enjoyed the job you gave me that I have decided to buy my own cannon."

Unfortunately there are many shiny cannons buried in R&D notes that may never be utilized simply because the magic formula to convert them to commercial products is wanting. Generally speaking, there are two kinds of information coming from R&D which must be carefully analyzed for possible commercial use: First, research information resulting from work which had no product objective in mind; and second, development information from projects carefully selected to meet a definite commercial goal. Development projects, if properly selected, are more easily understood and more readily assimilated by production and sales people. Research ideas, often less readily understood and assimilated, pose an additional problem in that the scientist or engineer interested in research frequently derives his primary satisfaction from discovering new materials, processes, knowledge, etc. Though not opposed to their use for profit, he may have neither the inclination nor the background to search for practical applications of his work. In fact, one of the steps in technology requiring the most imagination is that of finding possible practical uses for a completely new concept. It must be remembered that such entirely new concepts may lead to a most favorable competitive position and a real breakthrough in profits.

At the same time, one must not overlook the possibility that development information obtained in the solution of a specific problem for an imminent production item may lead to a completely new and different concept resulting in an unexpected breakthrough. The search for and recognition of such opportunities require a rare combination of power of observation, freedom from thought control by past art, and skepticism. I want to describe an outstanding example of this from our own experience at General Tire. In the late forties three of our R&D men conceived the idea that it should be possible to dilute a very tough, unprocessable butadiene-styrene rubber, of the composition then known as GR-S, with a cheap hydrocarbon oil and thereby soften the rubber and make it processable. Since everyone knew from experience with natural rubber that oil degrades rubber, our people expected to come up with a cheap mixture of relatively poor quality rubber which they hoped would have sufficiently good properties to be used as the low-grade polymer required for floor mats. Careful observation and analysis of the initial products, now known as oil-extended rubber, lead them to believe that this mixture of a very tough GR-S with 30% of cheap oil might even be useful for tire treads. More work bore out not only this, but also that the best treads, which were definately better than those in current use, were obtained when this mixture of oil and rubber was compounded in tread recipes as if it were 100% rubber. I might add that this concept was completely contrary to the teachings of the art of rubber compounding which dictated that the amount of carbon black to be added must always be determined alone by the amount of rubber hydrocarbon present. A little pencil work starting with GR-S at 25 cents a pound and oil at three cents a pound will tell you that oil-extended rubber reduced the cost of polymer for tire treads about 20%, although at the same time tire tread life was increased. About 53% of the annual 1,100,000 tons of butadiene-styrene rubber made today is oil extended. To me this is a classical example of an unexpected gain from a careful analysis of what might have been considered routine data. So many of the revered precepts of the art of compounding were violated in this development that selling oil-extended rubber to production was quite a job.

Let us turn now to the problem of transferring R&D information to production. That there is a problem is perhaps best attested by the great strides made in the utilization of technology in times of stress. There is perhaps no better example than the phenomenal growth of the synthetic rubber industry following the capture of the majority of the natural rubber producing areas in the Far East by the Japanese in 1942. So successful has this development been that we now have available not only a synthetic rubber exactly equivalent to natural rubber, but also many new rubbers which perform under conditions that natural rubber cannot tolerate. Yet the essential technology to produce a rubber quite satisfactory for small tire use was available and waiting to be used in the middle thirties before the war started.

Basically, this transfer of information from R&D to production is a sales problem and involves all of the elements that enter into any good sales promotion such as good communications, careful education, good intergroup relations, and enlightened leadership. No matter how good the technology, it is essential that production be completely sold, for in final analysis, the word of production people will necessarily carry great weight in management's decision whether or not to proceed in production with a given project. While developing such a sales program, it must be realized that R&D and production personnel have different training, inclination, and professional goals. Stated simply, R&D has the responsibility of seeking change: new or improved products. Production, on the other hand, is charged with the responsibility of maintaining status quo: to produce a product which day after day meets rigid quality control and cost specifications on which sales can unquestioningly depend. Reticence to change any part of a production procedure is readily understood when one considers that deficiencies in the product often, as in the tire industry, do not begin to show up for a matter of months after the product is in the hands of the customer. The interim production may then represent a serious liability.

Furthermore, production must operate in a rigid time frame, and deviations are costly and to be avoided; whereas the very nature of R&D precludes the possibility of rigid time schedules. When synthetic rubber was first introduced into the rubber factories during the forties, production schedules had to be so adjusted that the fervent plea of many a production man was: "Give us more natural rubber. We don't know what to do with this synthetic stuff." It is interesting to recall that in one of our plants by the time World War II had ended, a complete change in the technical production staff had occurred and the members of the new staff had grown up with synthetic rubber. When natural rubber returned after the war and they were sent a supply, a familiar plea was heard: "Send us more synthetic rubber. We don't know what to do with this natural stuff." It is often a matter of point of view.

These differences, and the fact that everybody has a lot of his own business to occupy his time, tend to make good communications between R&D and production difficult. Management should be fully aware of the possible existence of this difficulty and should take whatever steps may be necessary to maintain profitable communications. They should see to it that each has the opportunity to learn and speak the language of the other. Lack of understanding on the part of either should not be allowed to doom new ideas. Instead, a meeting of the minds must be achieved. Production must fully understand the economic importance of new and improved products and processes. They must fully realize that a business without new ideas, new processes, new products will one day wither away. They must also understand the necessity of being sympathetic to the disruptions in routine brought on during the introduction of new ideas.

R&D personnel, on the other hand, must learn to appreciate the importance that such items as capital investment, labor costs, overhead costs, promotion costs, sales capability, etc., bear on the final decision to transfer a new or improved product or process to production. They must also recognize that a new idea must be sold, that production generally will not come running to R&D for new products no matter how good the products appear to R&D. At the same time, R&D personnel should be urged to have no reticence in presenting new ideas and thoughts. Many a good idea has been lost or delayed because its sponsor was a bit too timid to propose it. Courage is required to speak out for something new, particularly when you consider that only a small percentage of new ideas prove to be fruitful, and nobody likes to be wrong.

There is no panacea for bridging the missing link. It must first be recognized that the transfer problem is really one of human engineering. Too often we think of technology transfer as the transfer of reports, etc., containing the new technology. Unfortunately the old saw about the horse and water can be transcribed to "you can pile a man's desk with reports but you can't make him read them." And anyway, as Mr. Parkinson recently pointed out: "Some firms have reached administrative self-sufficiency -- they can keep busy by reading their own memoranda."

The difference in general attitudes of R&D and production people already discussed require that a much more real and personal relationship be established between the parties involved in technology transfer. Several positive actions can be taken to help maintain the proper atmosphere. The choice of which action or actions to take will necessarily depend on the characterisitcs of the people available. A few of these courses of action are:

(1) Top management's desire for new products must be unequivocally passed down the ranks. Division management must be allowed to take the risk necessary to start new products and must understand that they will get special credit for starting successful new products.

(2) Steering committees made up of technical people from R&D, production, and sales may be established to monitor work in specific areas of company needs. There must be strong committees with management backing to spend the time required for full understanding of the problems and the methods being used to attack the problems. The stimulating effects of basic research scientists and engineers on such committees should not be underestimated.

(3) Various committees composed of both management and technical people, and sometimes sales people as well, may be utilized to consider the overall R&D proposals and help select suitable projects. Such committees frequently become ineffective rubber stamps, unfortunately, because the non-technical people involved simply do not have the understanding or the time required to master the job at hand. Some members frankly become bored.

(4) An overall technical director may be appointed to consider all technical problems including both R&D and production development. He must have enough stature to be able to sell his conclusions to production and to management. He should have sufficient background that he can fully comprehend the language of both R&D and production, and sufficient time to dig into what is going on in R&D to be sure nothing is overlooked. This requires an individual with a rare combination of talents indeed. You may have one in your company. But the hunting is tough.

(5) Periodic company-wide R&D and Production technical meetings may be used to keep these people informed of the work being done both in production development and in R&D, and to generate a real acquaintanceship among these people. It is very important that R&D personnel promoting a project be as well acquainted as possible with the people "buying" the project, and vice versa. Such meetings also serve to condition the production people so that an imminent new product idea does not appear quite so new, and hence so scary, when it reaches production.

(6) The interchange of personnel in both directions between R&D pilot plant and production may be used to acquaint the R&D man with the production problems he may face in getting his project accepted and give the production man a real understanding of the technology proposed for transfer. An unusual example of this occurred in our company when the initial small production unit for a new product was installed at R&D in Akron, shaken down, and then transferred, complete with the project engineer, to production in Toledo.

There are no doubt other ways of approaching the problem. The important thing is that management establish really effective liaison between R&D and production people--something much better than a mailboy throwing a pile of reports on the desk each day. On this liaison depends the really successful and effective use of R&D technology to make more profits for your company.

DISCUSSION

QUESTION: Most of the companies represented at the table have some business with the government; DOD or NASA. Do you, within your own companies, have a formal program that would pay for these federally funded developments and transfer them into a commercial application?

GAISER: I don't think I can say that we have any formal program to do that, except for reports that are distributed throughout the organization. We have no formal program for doing something like that.

QUESTION: Let me clarify that a little bit. My question is not about the transfer of information, but actually to have a planned program which takes the development funded by the government and work it through into some form that may actually become, at some point in time, applicable, and then apply it to a commercial environment.

SWARTOUT: In our case, most of our dealings with government agencies have concerned the Atomic Energy Commission. We face a problem that hasn't been mentioned here. This is the question of proprietary rights to such an invention. There are two factors in this. In some cases the company doing the R&D on contract retains some of the proprietary interest. The results of this work may be published, but the contractor who did the work still has a proprietary interest or partial proprietary interest. On the other hand, as in the case of the Atomic Energy Commission, the developments become the property of the government. In general, it's particularly true in our corporation, and I'm sure in others; we look very carefully before proceeding to develop any new process, where we do not have some preferred interest. Unless we have the patent rights, or some particular know-how, raw materials, or something where we will have an advantage over somebody else; there's no point in spending all this money it takes to go from the early invention or development. Other corporations are just as capable as we are. They have as much or more money, and they have just as good people. They can do the same thing. So we're not going to spend 50 million dollars to come out and develop a new process, when our neighbor can do the same thing.

QUESTION: Doesn't this same problem exist in the technology transfer that we've been talking about?

SWARTOUT: Yes. It does. This is one of the problems.

FAX: In interpreting your question a little bit differently, I can give you examples. We've had a research project on digital television, sponsored by a government agency. The work that was done in the digital television research has certainly been transferred within our company, into a television line. Not the consumer line but the studio type line. In monitors split screen generators, this sort of thing. The technologies acquired at that point are being used. Is this the sort of thing that you were wanting to know?

QUESTION: Was it planned? Or was it in retrospect?

FAX: I think it was in retrospect.

STEMPEL: If I may, I'd like to add one more note to this. I don't want to sound like I'm trying to top John Swartout. But in addition to the problem of patent protection, there is another problem even in those ideas, which in themselves, are not patentable. It's no secret that some government agencies are quite jealous of the work that they fund in the private concerns, and insist, and properly as a taxpayer, I agree; insist that the information that is generated from them be made equally available to all industry no later than it becomes available to commercial divisions of the company which operates the federally supported laboratory in which it was generated. This is done so that everyone has access to this information as quickly as possible, whether it's patentable or not. This, then, retards the planning of the transfer, if I correctly interpret your question. I'll also be quite frank to say that one of the reasons for engaging in such development is that the firm will hope that the momentum that is achieved in setting up an organization will somehow rub off. But in order to maintain good relationships with its customer, it must also be very jealous or zealous on its own part to make sure that it doesn't take undue advantage.

DI SALVO: To combine what both you and John have said; is it not true though, that the innovations or discoveries made by a firm doing government research are more likely to be in an area where the firm does have an advantage, be it raw material or previous experience. Therefore, if the knowledge is made available simultaneously to all people, they should still have the advantage.

STEMPEL: This is the momentum I referred to, yes.

QUESTION: I'd like to follow this point up with Dave Fax. A common comment that one hears relative to the quality and the content of the government report literature is that because of these very factors that you've pointed out, government contractors will put no more than they have to in a report to meet their contract requirements. Therefore, the quality of reports on technology that we can find in the government report literature is suspect. By suspect I mean not as high as may, in fact, exist. Would Dave or any of the rest of you care to comment on this?

FAX: I'll be glad to, since I've heard that claim made more than once. And I think, if you'll pardon me, it's unjustified, and to many extents, untrue. Engineers tend to write for their immediate audience. They also tend to write the answers they were asked to find; and rarely will they list, in their formal reports, all of the blind alleys that they went down in the processes of getting to that. Furthermore, government agencies have a wonderful staff of project officers, who are very zealous in monitoring the reports that issue. I wish the reports that are generated in our commercial divisions were up to the same quality in revealing what was actually done as reports that I'm familiar with; and I'm not trying to speak for the panel; that are written for government agencies. The latter are much higher in quality on the average, than the reports that are done in our own commercial divisions; whose answer always is, "our business is to generate products, not reports."

SWARTOUT: I think that there certainly are cases, and for good reason, where the reports aren't complete. For example, if a corporation takes a contract from an agency to take a process which the company has already developed on its own and develop it further; then in subsequent reports which are put out under government contract, you will see very little about the privately financed development. For example, we have a small contract now with the Office of Saline Water, using a process which we developed. We give the results in our reports but we don't describe how you make the gadget to do it. So, you could say the report isn't much good. And it isn't for somebody else; it's not supposed to be.

QUESTION: We've had rumors that the Treasury, I'm speaking of the Internal Revenue Service, would like to look on the results of research and development as the creation of some kind of capital or value. From what I've heard here this week, I think that most of the people who are engaged in technological research; think they are accumulating something of more than general worth. My question is: what effect would an interpretation of this kind, that research and development expenses could not be deducted for tax purposes, have in the research and development budgets of the companies?

STEMPEL: Well, a non-deductible expense, will have to be amortized in some way over the product that eventually results, if any. And the last thing in the world that I am is a tax expert. I really don't know quite how that would work in. It certainly would work to the contrary interest, because it would be immediate taxes, rather than the deferred taxes.

QUESTION: Isn't that primarily what it is? It all depends on when you do it. But if you buy land or machines or buildings or anything else, there is some long term rate over which you depreciate them. I presume you wouldn't have a research investment on which you would never depreciate it. But you have to write it off somehow, sometime. So, it would just be whether you write it off currently or over "X" years.

STEMPEL: If it's considered to be depreciable, yes. It could be written off over a period of time.

COMMENT: It would have to be depreciable some time, I assume.

STEMPEL: Well this isn't necessarily so. In the case of some that we've mentioned, they are now acquiring technology by buying companies. If, because of the technology a company has, you pay more than the value of the tangible assets, I would think you've got a non-depreciable investment.

SWARTOUT: Any technology we buy, patents or otherwise, are, of course, capital assets.

GAISER: However, this is one of the biggest headaches you run into, when you try to merge or acquire a company. You've got to fit it into some sort of framework in which you can write it down somehow. If you get hung with fringe benefits, good will, stuff like that for 6 million dollars worth of development, this can be quite a burden on you for a while.

QUESTION: I was wondering if in General Tire, Westinghouse, and General Electric has any thought been given for a planned transfer of people from aerospace work to commercial work, and vice versa, to try to get your technology transfer across divisional boundaries in that fashion? Not just happen stance flow, but a planned flow. Is it worthwhile even thinking about?

DUNN: When you say is it planned between those areas, in our case, not any more than it is among all of the divisions and activities, where the transfer is accomplished by the movement through central inventories and this type thing. But what often happens is, that in the government work, you're reaching towards an application that perhaps hasn't been obtained or is new, or is beyond what you're doing in the commercial business. You do this in laboratories or engineering organizations along with the people working on the commercial products. They really are, perhaps, part-time people on a government application. In this sense, you get a transfer right within a given operation within the two kinds of work. This is the most common kind of transfer of the government technology that we experience, at least in those areas that are in any way related to a commercial activity in which we are engaged. There's movement of people, but I don't think you could say that it's deliberate between those areas as versus all the areas.

GAISER: I might make this comment. We did something like this, but it was planned for us. We had practically 100% government work. And we were trying very hard to change that balance. The fellow who built our first satellite did the planning for us. He said, "I've had all of the government project engineers I want to handle, and I'm getting out of the space business." So, he became our commercial product manager and took people with him from the aerospace group, and has done a very good job.

STEMPEL: This is sort of the anti-climax. I can't really tell you much about Aerojet. It's kept quite separate from General Tire. But I will say this much, there is a very concerted effort within Aerojet to take "spin-off" and develop new industries, new businesses of their own. These remain a part of Aerojet, rather than a part of General Tire, as we separate the two. I think maybe this is what you're referring to.

DI SALVO: Well, I think I'll extend this to you, John. Do you have any planned program, say in the Oak Ridge staff, or are they not under your domain? Do you do anything systematically in transferring these people to commercial sections of Union Carbide?

SWARTOUT: A number of them have transferred, including me. But there's been no planned transfer. In fact, as a matter of policy and ethics, we have leaned over backwards not to do this. We think that the general policy has been set that this technology, which is paid for by the taxpayer, should be available to everybody equally. So, we have no planned, and won't have any planned system for transfer of people because of the technology they picked up there. We choose them for their capabilities, which of course includes their experience. You can't avoid this.

QUESTION: Has there been an attempt in any of the companies represented to measure profit or revenues that you might have derived from being in the federal market? I'll be more specific. Within the federal market, you're relatively limited to the profits due to regulations. The profits you derive are usually much less than those you would have derived in a commercial environment; therefore, from a corporate point of view, there must be other reasons to be in the federally orientated market environment than profit. I guess I'm really asking why are some of you represented in the federal market, since profit must not be the primary motivation?

SWARTOUT: I think you have to define the market here. First, the clear-cut market is the sale of products to the government. Here, the profits can be just the same as anywhere else. Of course, we do it. We sell tremendous amounts of oxygen, etc. to NASA. And when you're speaking of conducting our research and development for the government under contract, then of course, the profit is not very large. And in the case of our corporation, we have intensely stayed away from conducting R & D in our private facilities for the government. Because we think we can make better use of our people in private than we can for government research. We do, of course, operate very large installations for the government, that belong to the government. We do government R & D, but not very much of it. This is true, in general, of the chemical companies. The reason is that their own private business is pretty profitable. You can't get a 10% return after taxes from the government.

ADAMS: How do you do it commercially?

SWARTOUT: Well, we still get it, but it's hard.

GAISER: I might make just a comment on that, being from a smaller company, 120 to 130 million dollar company, and a diverse company; small in almost everything we do, but diverse. We can't afford to sponsor research that's really meaningful in each one of these diverse product areas. It's very beneficial for us to do research for the government; development work, I should say, development engineering work for them. We then can maintain a staff of top professional people, who you might say are permanent consultants for other areas of our business. I think this is very advantageous for a smaller size company. For Union Carbide or General Tire or General Electric, this is quite a different story. But for us, it's great.

FAX: Federal R & D is attractive for a variety of reasons, and as you say the profit is not the only attraction. There's always the hope that, as John pointed out, ultimate product profitability will result from it, in which the doer of the R & D will have some initial advantage. There's also the fact that it's a way of keeping an organization alive. This comes back to a question asked previously about the planned transfer of people from federal installations, if you will, or projects funded by federal funds to a commercial part of the operation. As the other gentlemen of the panel answered, I also say that I know of no formal plans in this area in our own company, but it does happen. It happens for this reason; that research and development of the nature that the government sponsors is very attractive work. It attracts high caliber people. After a while, these high-caliber people bubble to the top, and perhaps they outgrow the jobs in which they're placed in the R & D and advanced work. And they become likely candidates for transfer to executive or top administrative positions in the rest of the corporation. That's a wonderful way of keeping the top echelons alive. It does happen. It's not a formal plan. The better men, for one reason or another, become apparent, and as a way of keeping a fresh supply of fresh ideas, doing good R & D is hard to beat. You just can't afford not to do it, is the way many people look at it.

QUESTION: First, I want to ramble. Ethics and patent laws have been mentioned. Patents pertain essentially to something that is physical; that represents a physical embodiment of an idea. Ideas themselves are not patentable, as I understand it. You cannot copyright an idea. You can only copyright words or symbols. The textbooks and all other books mentioned here today have a page set aside, which says this material cannot be reproduced, in whole or in part, by any means whatsoever. I think they're referring to Xerox. But the students go to the libraries and immediately Xerox these things, and that gives an illegality in the strict technical sense of the word.

It's also been mentioned on the panel today that one way you can get information that you do not otherwise have access to is to buy the people in whose heads this information resides. That's why I've mentioned the ethical proposition of transferring people that have access to information which is not generally available to other industrial corporations. It seems to me like the fault lies in part, with the artificial requirements or the legal requirements; artificial in that it is generated by the society; in transmitting and utilizing information as a resource. But we do not have such technical barriers against other forms of things which generate economic growth; land, labor, capital. I would like to throw out a prediction that the patent laws and the copyright laws will one day cease to exist. I think it behooves us to think of ways to handle information, to operate companies, and to make money, and to grow, without these artificial barriers. What would be your reaction to such a proposition?

GAISER: The only comment that I'd make; you'll have more trade secrets. Right now, much of the technology within a corporation is held as a trade secret; rather than putting it through the formality of a patent application. I suspect you'd have more of that, which might be worse. I don't know. I've never thought about this.

ADAMS: It would make industrial espionage a lot more profitable.

STEMPEL: I'd like to be academic on this thing for just a minute. The patent system was originally invented, and its name patent comes from the word meaning "to make open", or to disclose. To reward those who are willing to disclose what they've invented; that is to reward them by giving some exclusive rights for a finite period of time. What's happened to the patent system, since, by the general legislative, administrative and social processes, has encrusted this with some other interferring barriers, which you've cited. But I don't think the solution is to kill the patient, because if you did, I think, as has already been pointed out; that the results would be inimical to society, rather than beneficial. If there is a system of rewards for doing something well, that I think, basically, is the way to get it out into the open, where others can ultimately reap the benefits; particularly consumers. So, I don't think that the solution lies in the direction of destroying or eliminating the patent and copyright system; but rather to find a better way to live within your original framework. And what that might be, I'm not about to suggest.

QUESTION: A lot of my friends have had some interest in recent years in the concept of patent marketing. I believe General Electric and 3M, and various of the other large corporations have attempted to package ideas, within divisions in their corporations; and first give a right of refusal to other divisions to use those unworked patents; and then go outside the corporation with a package that they try to peddle to other firms. Is this working? Is General Electric still doing this?

DUNN: Yes, and it arose from the recognition that we did have a number of patents around that were not being utilized or, at least, we thought they might be marketable. They have been. It's a matter of giving some attention to it. We never were particularly aggressive over the years in either marketing patents or defending patent positions. I don't think the reliance on patents is nearly as great as it used to be. We for one, and perhaps others, have a fairly open policy of licensing on most patents. So, they are made generally available to a very great extent; not only by this means, but through the process of normal re-licensing and this type of thing.

STEMPEL: This discussion of patents disappearing and trade secrets reminds me of a very early example of technology transfer in Akron. About 50 years ago it was discovered that certain organic chemicals added to rubber compounds caused the vulcanization process to be accelerated greatly. Now, in those days, a technical man from one company did not dare to be seen walking down the street with a technical man from another company. It was that tight. So, one of the competitors decided the way to do this research job in a hurry was to hire somebody from the first company who knew how the process worked. Well, they did. They hired the man who makes the rubber. And they gave him a fabulous salary; brought him in; put him to work. And asked him what he needed. He said he needed 500 pounds of code 432. He didn't know what the code numbers were. This might come back, if we discontinue patents.

END OF SESSION

SESSION NO. 11

THE IMPACT OF NASA R&D PROGRAMS ON MANAGEMENT AND ECONOMIC GROWTH

Moderator:
L. L. Waters
University Professor of Transportation
Indiana University

Panelists:
George W. Wilson
Chairman, Department of Economics
Indiana University

John F. Mee
Mead Johnson Professor of Management
Dean, Division of General and Technical Studies
Indiana University

L. Keith Caldwell
Professor of Government
Indiana University

SUMMARY OF REMARKS BY L. L. WATERS

Dr. Waters opened the session with the observation that he had been a 'long distance peeping Tom' on the transfer of technology and the transfer of management for a period of months; not being identified with any of the organizations that are generating it or receiving it, but just trying to read most everything that came out. Impressions he gained from these observations included the following. Once in a while, you transfer some 'piddling' little thing; there must be a reason. What is transferable? It's one thing to face the transfer of gadgets and things that you can see. What may be more difficult is the transfer of ideas, ideas about management. There's a possibility of the transfer of the whole idea of NASA; of the whole managerial concept. It represents a unique wedlock of government and business that has accomplished a goal.

Exploring the transfer of the concept he suggested that we identify 8 or 9 other goals that seem to be too big to be attacked by the private sector or the public sector, but might, in concert, be tackled together, for instance air pollution, or congestion in the cities. Transfer over the NASA concept and a colosial lession might result from this whole experience. Instead of the man on the moon by 1970, by 1977 the bacterial count of the water flowing out of the Ohio River into the Mississippi shall achieve a specified amount. Turn around and work backwards. What causes the bacterial count to be somewhere short of raw sewage; see what the aggregate costs involved are and determine whether or not this is really something that ought to be done. Based on this, set a specific target and go to work on it using the identical techniques.

Lest we become elated Dr. Waters discussed some unsuccessful transfers of management technology. The first involved a merger. The company was involved in a merger because it had a surplus in management which needed a challenge to keep them going. They had some techniques, that in the trucking business were superb. So, they bought a company with beautiful operating rights and thought they would apply the same techniques. They went into a terminal in Chicago. They installed their techniques but the terminal was operated just as badly as it had been under the previous management. The ideas didn't transfer. Why? Primarily because 'hard goods', tactics don't work with the people. The people had bad habits so ingrained in them, that to get them to change was absolutely impossible. The conclusion, after much frustration was that the smart thing to do was make all the typists load and unload trucks. And the people that couldn't type run in and do the typing, to get better productivity. Indeed, where they opened up whole new operations with all new people, they hit targets of performance much more rapidly.

Similarly, Dr. Waters pointed out that this is why, in some of the international programs we've concluded that the best way to transfer American management ideas to other countries, is to bring those people over here, and let them study how we do it. Then they go back and adapt what they've learned to their particular situation. And sometimes do a lot better job. He compared this to Dr. Duberg's comments at lunch on the flow of people through key positions, as a principle means of transferring enormous amounts of management technique and practices. He proposed that NASA study what has happened to all the people who have come in and gone out of their organization and analyze the marvelous education they've had. This could be followed up with an analysis of how they behaved differently on their return to the industrial community.

THE IMPACT OF THE SPACE PROGRAM ON THE DOMESTIC ECONOMY: SOME RANDOM REMARKS

by

George W. Wilson

In this area there is a great problem of trying to say anything new regarding the impact of NASA. We need far more specific studies of particular situations and then some careful and organized appraisal to attempt to derive some meaningful generalizations. What I propose to do is to present a catalog of approaches and views each of which requires more extensive analysis and documentation.

The space program can be viewed in a wide variety of different but overlapping contexts. The effects, from each viewpoint, are fairly easy to infer in a general sense but extremely hard to quantify or document adequately. Let me review the various contexts from a strictly economic point of view.

First, the aggregative point of view. NASA's expenditures for R and D can be viewed as simply part of government's GNP purchases. As such their effects are frequently, but often erroneously, deemed to be identical to any other kind of government GNP purchases. Hence a rise in NASA outlays will be either good or bad depending upon the level of output of the economy at the time relative to economic capacity, that is to say, relative to full employment GNP.

Up until about mid-1965 when the company had lots of slack, a rise in government expenditures could be deemed desirable. Since mid-'65 a rise in government expenditures, other things being equal, presupposes a rise in taxes and/or some cut back in other expenditures public or private to offset inflationary tendencies. In short, since mid-'65 NASA outlays have become far more competitive with other public programs than ever before. It is no accident that more and more people are calling now for a comparative evaluation of NASA with, say, urban renewal, poverty programs, military expenditures and other public activities deemed to be of higher priority or at least more urgently needed. The lack of an adequate calculus of expected benefits vis a vis costs turns this evaluation far more into an emotional or judgmental than a rational comparison.

But the message, of which NASA officials are acutely aware, is that they must attempt to demonstrate more convincingly than ever before in the past that as far as the domestic economy is concerned the NASA budget is a worthwhile use of economic resources. This really requires more than random *ad hoc* evidence with respect to product spillovers. Reliance on simply cataloging or listing the various products or processes deemed to have emanated from the space program, impressive as this list may be, will not suffice to justify high levels of funding.

It has been suggested that one of the major accomplishments of the space program has been the development of the technique of organizing and directing vast team efforts on an inter-disciplinary, multi-industry basis. This has even been referred to as a new social instrument. "It is precisely this powerful and relatively new technique of large scale organization focused upon major project objectives that most sharply distinguishes military and space endeavors from R and D in the private sector."[1] If this is the case, then it is clear that the arguments stressing product spillover are self-defeating, because, "if one believes that the deliberate application of effort toward a specific goal is the way to reach it, and if one has such goals in mind for the private"[2] or public sectors, then it makes far more sense to organize programs and projects directly oriented to these goals. "Spillover is too uncertain, too inefficient, and too long in coming"[3] to satisfy urgent needs that must be met elsewhere (e.g. the cities). Furthermore it is probably the case that the intangible spillovers or the intangible benefits of the space program are more significant than the so-called tangible products that one may or may not succeed in identifying.[4]

But regardless of these points at least after 1970, NASA does not as yet have a specific mission mandate the effectuation of which is to be accomplished regardless of spillovers, although the more positive spillovers the better. But the spillovers, as indicated above, in fact as the term itself implies, are more or less accidental byproducts. From now on the mission itself may become more of a byproduct with the real purpose to stimulate economic growth via invention and technical change. This of course raises very thorny questions regarding direct versus indirect approaches. More substantial efforts at technology identification, diffusion and transmission can, of course, help maximize spillover and make it far less accidental. It is indeed not fortuitous that NASA, unlike DOD, works rather hard in this endeavor mainly because of the greater need for NASA to justify its budget more and more in terms of positive benefits to the domestic economy. DOD, on the other hand, has an easy time especially when major military operations are being conducted.

A second approach at the aggregate level is a much more qualitative one. That is, instead of viewing NASA expenditures and their effects as precisely analagous to any other government expenditures, one might view the space programs as being significant stimulators of research and development which

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[1]The Role and Effect of Technology in the Nation's Economy, Part I, Hearings, Select Committee on Small Business, United States Senate, Washington, D. C., May 20, 1963, p. 35.

[2]Ibid.

[3]Ibid.

[4]John G. Welles and R. H. Waterman, Jr., "Space Technology: Pay-Off from Spin-Off," Harvard Business Review, July-August, 1964.

leads to invention which hopefully leads to innovation and so on. These in turn are often felt to be major sources of economic growth. Therefore, to the extent that NASA expenditures do stimulate growth, they should be viewed as "investments." That is to say, they are potential capacity-enhancing outlays regardless of short-run inflationary pressures, and they may, therefore, be contracted with other public outlays some of which may not have this investment-type aspect or at least productivity-enhancing component. But, unfortunately for this view, there are various considerations which temper one's enthusiasm for it. The relationships among invention, innovation, research and development to economic growth are very complex.[5] In particular, there is no close correlation between R and D outlays and economic growth nor between NASA activities and R and D itself. In fact we really know very little about the causes of economic growth in general, let alone NASA's contributions thereto. Furthermore, other public outlays, for example the urban programs, poverty programs, education and so on are also being viewed as investments.

There are in fact only two ways to justify any particular level of expenditures for space exploration, neither one of which is capable of providing any notion of precise magnitudes at least with the present limitations of knowledge. First, a belief that the United States must remain ahead of the Soviet Union in space technology for prestige and/or possibly military purposes. With respect to prestige, I think we should not downgrade this unduly. Prior to the first U. S. space success, after many agonizing failures, a common joke, in Europe at least, went something as follows: "Why is a U. S. missile like a civil servant? Answer: It doesn't work and it can't be fired." Let us not discount too heavily the prestige, face, or image factor, especially at a time when U. S. policy is under heavy attack throughout the world. In any event, prestige, Soviet competition and perhaps military reasons would justify some level of effort in space despite any lack of economic rationale. This is a highly subjective matter and not much more can be said of it.

More important, however, is the second reason. The real impact of NASA may mainly be to create a psychological climate that is universally stimulating. This is the program itself may have succeeded in enhancing more generally the incentives to innovate. If we can get men to the moon and back the probability is high that we can solve, for example, such a mundane problem as the hot box in the railroad industry or other sometimes grubby, technical problems that might otherwise have been felt insoluble or toward which efforts may not have been directed. The essential message of the success of NASA is surely that whatever the aim or goal in the physical sense, we can achieve it with adequate effort.

I have long been impressed with the fact that World War II, terrible as it was, nevertheless provided a kind of forced draft on the economy which propelled us upward to levels of production higher than anyone would

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[5]Some of the problems in this catena are summarized in George W. Wilson, Innovation in a Competitive Environment, ARAC, November 17, 1964.

have dared predict coming out of the pessimism of the 1930's. I would go so far as to guess that our present level of GNP would be at least $100 billion less had World War II not occurred and demonstrated what we could do and could have done all along had we only made the attempt. The Manhattan Project has certain comparable features. So World War II, the Manhattan Project and now manned space flight have increased our confidence in our ability to solve hard technical and economic problems and even more importantly this confidence does not seem to be misplaced. NASA in other words is like a driving wedge showing us that we can do things we would never before have even dreamed of attempting. It is of course legitimate to examine the opportunity cost of NASA's appropriations. But the modd created, to the effect that no technical problem once identified will long go unresolved if only we make an effort, is vital for sustaining an innovative climate and this is crucial to economic growth. This attitude seems to have permeated the business community.

Let us now look briefly at some of the disaggregative effects.

REGIONAL IMPACT: The distribution of NASA contract awards is highly unequal among regions compared with either the distribution of population or personal income. Furthermore, this inequality is such that, other things being equal, it accentuates differences in personal income per head, and thereby makes it harder to achieve one goal of policy, namely, greater regional equality. It is by now pretty well established that once regional inequality gets enhanced it tends to become cumulative unless government or some outside agency supports a set of policies or investments designed to reverse what would otherwise be ever-increasing and widening disparities.

The reason for the inequality of NASA procurement is of course obvious. In fact there is a close resemblance between the geographical distribution of civilian space work and the state-by-state distribution of missile employment in 1958, before the beginning of the NASA program. Thus the contracts naturally went where the expertise already existed. NASA had no choice. But, however reasonable or inevitable this might have been the effect is to perpetuate, aggrevate or accentuate regional disparities.

LOCAL IMPACT: The effects of the space program can also be viewed at the local level, that is to say counties or cities. The general impact on communities where extensive space facilities exist is fairly obvious and need not be documented here. Various studies have analyzed what has happened in retail trade, employment, number of business establishments and so on due to the multiplier effect of expenditures in the local community. There are many other possible and more subtle effects but these may differ substantially among communities depending upon the initial situation.

INDUSTRIAL IMPACT: Demand for the kinds of things NASA requires stimulates the growth of a new set of industries or at least orients part of previous industries in new directions. This is implied in the phrase "aerospace industries." Since so much of the NASA program requires research and development, concentration in a few industries likewise serves to concentratrate research and development or at least make it more concentrated than it would otherwise have been. For example, the proportion of industry R and D performed by aircraft and missiles, electrical equipment and communications is roughly 60% of total industry R and D whereas their contribution to value-added is only about 12%. On the other hand who can doubt that present total R and D is substantially higher than it would have been without NASA? Thus while it may be concentrated, its aggregate level is greater so it may still be more widely diffused than without the NASA program at all. Indeed if the psychological reasons mentioned earlier are valid this is precisely what is implied.

If we ask the question concerning the appropriateness of the level and composition of R and D we are faced with a much trickier question. Even if we argue that the space program has increased total research and development and perhaps even raised slightly the ratio of "basic" to total R and D we still cannot judge whether either of these is optimal. We may suspect that both effects are desirable, but it is very hard to prove in any benefit versus cost sense.

EFFECTS ON INDUSTRIAL EFFICIENCY: NASA procurement necessarily stresses reliability and on time delivery and this is often at the expense of cost. Indeed the entire procurement of weapons, missiles, and advanced hardware is done in a context considerably different from what are euphemistically called "ordinary market processes." There is not only greater uncertainty which means that cost estimates are frequently understated but there are large sums directly involved which raises the problem of indivisibility of huge lump sum commitments. The environment itself is dynamic--constant changes occur in the product during the contract period. There is a far greater need for special facilities and skills or brand new ones that had never even been thought about before than in other areas of contracting.

EFFECTS ON MANPOWER: It is fairly obvious that the space program has accentuated short-run manpower problems by creating excess demands for relatively scarce skilled personnel. It has been argued that more than two thirds of America's top scientists and engineers are devoting their full time to research and development on national defense, the space effort and atomic energy. Thus NASA places new demands on the skill composition of the labor force which in the short run is extremely difficult to match. There is a partial offset here in the longer run, through stimulating more people to enter the needed disciplines although there are other ways of accomplishing this particular goal.

CONCLUSION

You will note that I have not specifically mentioned the particular set of products developed thus far as a spillover from the space program. These have been specified many times and their importance stressed. (e.g. Minaturization, walking chair, 30 day catheter tubes, electromagnetic hammer, new alloys, biosensors, eye-activated switches, battery developments, etc.)

The nagging question is, did we need the space program to obtain these things? Could we not have developed each of them without all the costly apparatus and unrelated activities? The answer is clearly, yes, we could have. But, I am less sure we would have. Presumably we have had these technical capacities for many years, if not decades. Why were they not developed before? The needs for many of them are not necessarily more pressing now than in the past, although our technical capacity is rather better. I suspect that NASA has contributed to the technical capacity which makes it easier to develop these things. I also suspect, that unless all of the spillovers, or at least a vast range of them, had been foreseen as a package, we would not have invested much in any one of these singly. And to see these all as a package would have required a degree of prescience not to have been expected. In short, no one of these would seem to have justified the needed investments and efforts; although it is possible that, as a group, they might have; but, so heterogenous are they that it is unlikely that anyone could have viewed the whole package. Thus, we probably needed some specific, major objective and undertaking that required the investments, organization, and all that. Probably, the nature of the objective is unimportant so long as radical new techniques are involved. But no such massive effort was mobilized despite the long persistence and continued aggravation of urban problems. After Sputnik, space exploration provided a nationally accepted goal requiring a massive effort, involving new techniques in science, engineering as well as organization. At the present time, we have several choices: (a) continue with equal vigor, space explorations, (b) redirect efforts toward mining or milling the new technology--after all, with long gestation and diffusion periods the important technological discoveries that will have a substantial economic impact in the next decade or so are already in an "identifiable stage of commercial development," (c) some combination of the two. What is optimal strategy under present conditions deserves careful scrutiny. At the very least, the time seems ripe for the kind of research that would permit less ambiguous answers to questions concerning the impact of the space program on the domestic economy.

SUMMARY OF REMARKS BY JOHN F. MEE

Dr. Mee's comments related primarily to the impact of NASA on the field of management. He called them a staff assistant's report on what's happened in the field of management within NASA. "As our feet have trod forward; we've left our heads behind," was given as the theme. The 'triple revolution' has replaced the industrial revolution in management texts, he said. Those to whom the future belongs, are programmed with a 'triple revolution,' the weaponery revolution, the cybernetics revolution, and the human rights revolution. He agreed with Dr. Wilson that a large part of this is psychological.

He said NASA will have more impact on economic growth and social progress through management thought than through the technology developed. This is because the change in management thinking is far more revolutionary than the scientific management movement at the turn of the century. Identifying 1910 or 1911 as a turning point, when the United States moved from an agricultural economy into the greatest industrial and business society in the world. He suggested that in the last third of this century, the industrial society is now routine; and we're moving into a science-based technological society.

He stated the record of business in an industrial society. The United States, one nation out of some 135 nations in the world; 125 in the United Nations; has grown in the past 50 years from about 15% of the world's wealth to about half of the world's wealth; and 35 to 40% of the world's annual income. The United States, with about 6% of the world's people now has about half the world's wealth. He contrasted this to Asia which has most of the people and little of the wealth.

Dr. Mee observed that in the past, we've thought that as long as we were busy and did our duties we were virtuous. Today, under the new management, the payoff is on results rather than on efforts. He emphasized this with examples. The zero defects program came as the result of the need within the space industry for a different way of management thinking. Under scientific management a warranty was used. If the product wasn't quite right, you negotiated and made good on the warranty. When you get into the space industry you've got an astronaut 60 thousand miles on his way to a 240 thousand mile trip to the moon, and something goes wrong. He wonders what he does with his warranty, hence zero defects programs. Firms have now developed their own counterparts: STEP, striving toward errorless performance; PRIDE, personal responsibility in daily effort; COACH, charter of accountability concept for Hughes; I.Q., improvement of quality. In this same context he placed RCA's performance goals and appraisal programs where all managers are evaluated on their performance towards the goal that's set. The performance appraisal; replaces loyalty, dependability, and all the subjective evaluations that previously appeared in job evaluation and wage incentive programs.

He cautioned that many firms have gotten into trouble with just this concept, because it is only the first step, it's an option, or an intent. Many firms today, as a result of this, are virtually writing their annual reports for 1970 or 1975. Once the annual report is written for 1970 or 1975, as to where they want to be; their accomplishments, whether it's return on investments, sales or profits, their share of the disposable personal income; or whatever result they want; they then set out, with a series of events, changes, and efforts designed to cause, or to bring that into realization. This is different from the economists way of thinking. In this way of management thinking, stimulated by NASA, instead of allocating scarce resources; you create or make whatever resource you need. It's a concept of whatever man can imagine, man can do.

Dr. Mee suggested that this brings about many concepts that offend us; the decline of bureaucracy for instance. Bureaucracy reached its height under an industrial society, and under scientific management. He referred to an article in the current issue of Fortune Magazine, about NASA and the administrator, suggesting that the staff writer had very little background in management. The writer criticized NASA for having developed an organization that has pockets of sovereignty. Dr. Mee countered this with the argument that that is what has made NASA successful. Without the concept of pockets of sovereignty, which is another way of talking about the new forms of organization; such as project management, or program management, or the matrix organization, or the project organization, NASA would not have achieved its goal. He pointed out that a good school of business or engineering, no longer teaches the line and staff organization. More and more people are now performing the management function instead of "the man." Scientific management has given way to participative management; where an individual has both legal authority and de facto authority; which comes from his knowledge, his skills and his profeciency. This has changed our whole concept of ownership preference, he said.

Dr. Mee observed that the impact of this is to make knowledge, skills and a value system that makes one useful in contributing to whatever objectives are set, the most prized possessions of the next third of a century. Today, the students that come out of school are starting out with a need for self-esteem, a need for achievement, or self-fulfillment. They're expecting the climate resulting from the new type of management, because that's all they know. As a result, the management education programs, executive programs must explain to older managers the new way of management thinking. He compared the new management to the 'westerns' on television. The hero always wins. You always know that there's a man coming in with a faster gun. The old sheriff is uneasy. He's done a good job. He's minded the store. But he knows some day he'll die in the street. Pointing out that in management today it's far easier to get educated than it is to stay educated he emphasized the need for executive development programs.

Dr. Mee then suggested that NASA has provided us with mixed blessings, on the good side NASA has stimulated the systems concept of management. To the young management professors and the school of business students today, everything is a system. But today, our technology has advanced so far that most of our people are having trouble developing their competence to the level of sophistication of these systems. The system is great. But we are hard-put to bring our human element up to cope with these particular systems. He then discussed changes in education. At one time, an eighth grade education would serve a man to make a living. Now our value system includes 12 years of education. He suggested that we are just about to see 14 years free education, 2 years beyond the high school level with the training of a large number of technicians in the systems concept.

Dr. Mee reemphasized the warning that technology programs and personnel programs are getting dangerously out of balance. He urged the pursuit on the part of firms of a better balance between their human assets and their R & D. Because in the near future, the human asset will be more important on the balance sheet than the capital asset. He observed that business and government are coming much closer together. The Chief Executive Office of the United States in 1965 set a national objective of 5% economic annual growth, under a policy of full employment. It's far easier for us to get that 5% economic growth than it is the full employment. One of the less desirable results of the systems concept and the increase in our technology is the emergence of pockets of people, who have moved from an agricultural economy to urban areas. They represent a resource to be utilized somewhere. Various business firms have pledged to take some incompetent, unemployable people, hire them and try to train them. He advised starting subsidiary firms for them, rather than trying to work them into their own operation.

He said, "if we don't use this knowledge for our water or air pollution control, for instance, we will be described as a nation, that in the last third of this century, stood up to our waste and sewage while firing rockets to the moon. We're far more competent, you see, in space, than we are in waste control, sewage control, traffic control, and all this."

He then turned his attention to objectives. The first objective of NASA, he said, was a beautiful objective; complete capability in space. The trouble was it's like trying to nail jello to a tree. You can't get hold of it. NASA gave it a specific, quantifiable, realistic, interpretation--putting a man on the moon and returning him by 1970. This changed that whole way of thinking. It was revolutionary. In about 10 years this will have been accomplished. To emphasize the importance of objectives, he cited a less favorable national project, the National Defense Act of 1956 on the interstate highways. Ten years have been spent on interstate highways; they're only about half finished, and many are already obsolete. The problem here was that the objective was not really to develop the interstate highway system. The economy was a little soft in 1955. If you measured this project by the Employment Act of 1946, whose objective was to provide employment and buoy up the economy, then it achieved that objective. But if you measured it by our interstate highway system, it falls short.

Dr. Mee concluded that NASA is making a tremendous impact on schools of business. It is going to create some tremendous thinking. This way of management thinking makes a large part of the old school of business obsolete. The systems concept of the interdependency of all parts of a business or an economy, or states; sub-systems and total systems; each one having specific, quantifiable, realistic objectives to accomplish; is going to have a tremendous impact on our ability to accomplish things, whatever it might be in the United States. But it's a traumatic experience for those who have been programmed in scientific management, to have to learn this new way of thinking.

SUMMARY OF REMARKS BY KEITH CALDWELL

Dr. Caldwell suggested that the previous comments would obviously have tremendous implications for the shape of American society; and hence for its governmental and political institutions. He emphasized Dr. Mee's remarks on interdependence, and Dr. Wilson's that the psychological impact of the space program, was perhaps the most important of the NASA contribution. He concurred with these observations but for different reasons. Concerning interdependency, it's just as true in the teaching of political science as it is in management that most of the literature is of only historical interest, he said. The facts of life in American government today are very different indeed from those that were taught in courses in civics or political science, or even in constitutional law. Within the past quarter century, a new kind of society has been created that we're hardly aware of. We've created things that have no precedents. He suggested that we have in fact, created a type of society that hasn't existed before. Some have described it as the technological society. John Galbraith has described it as an industrial state. It has something in its character that does not respond to the kind of society for which the constitution was framed in Philadelphia in 1789. He observed that society today is symbolized by NASA more sharply than by any other agency, even though the inter-relationships, the inter-dependencies between what we think of as government and what we think of as the enterprise system are not new. They began to develop very early in our national history. To emphasize this Dr. Caldwell cited the 1830's and the periods of canal building; governmental entrepreneurial relationships in the field of agriculture; and more recently in the space program, the defense program, atomic energy, and even in the fields of biomedicine.

He stated that we can no longer tell where government ends, and where non-government begins. The terms public and private are losing their significance. To say that the Boeing Aircraft Company, for example, is a private business enterprise, is, ridiculous, he said. It's a public corporation. The question is how these public corporations including the universities and the research institutions, relate to one another. Where do you affix responsibility? How do you articulate these components into systems that will serve a variety of social needs; the problems of the cities, the problems of the environment? How this is to be done, we have yet to discover, he said.

Dr. Caldwell then turned his attention to the psychological impact. A particular psychological effect of the space program is the power of the model of the space ship, he said. We never had anything like a space ship before. We've had the expression 'microcosom' or little world; little cosmos, but we've never had one before. The space ship is one. He pointed out that a number of people, including Adlai Stevenson have used the term 'space ship earth'. The space ship has been called a model for human society. Urban deterioration, environmental pollution, and a host of problems grow out of living together in a finite world. That world has only become finite within the present century. We're only beginning to realize how finite it is, as a part of the space program, he said. We recognize in a way now that we never could have realized before, what an inhospitable place the universe is.

Dr. Caldwell concluded by referring to a space ship as a perfect example of an ecological system. It's the first time that we have been able to conceptualize the human predicament. It may well be that this particular model will have as comparable an effect on men's imaginations as anything that comes out of the space program. It may well be the stimulus that is needed to bring about a new articulation of these systems for the purposes of the more effective management of human environment. He endorsed the statement that we know a great deal more about the management of the physical and biological world than we are able to apply through our technology; not because the technical means are not available, or the economic resources are not available; but the human mind has not accomodated itself to the necessity for doing this.

DISCUSSION

WATERS: John, we even had a problem this past year where we hired some new instructors who were claiming that they were graduating with an MBA now obsolete.

MEE: Yes, if a man doesn't hurry through and get his Doctorate quickly, he can't pass the exam for the younger instructors, based on the work he's had from the older instructors.

WATERS: About three years ago, I had a program for retreading teachers. We had four people who were between 55 and 59 in the program. And four who were between 27 and 29. When we evaluated the results; three of those between 55 and 59 were younger in openness of mind, capacity to learn and sense of excitement about new knowledge, than any of the four who at 29 had gone to bed intellectually. You're only as young as the openness of your mind, at least for purposes of management and learning.

MEE: I want to switch channels here a minute. Inasmuch as the NASA job is not wholly done with civil servants, but uses 20 thousand subcontractors, don't you believe that private enterprise will be called upon more and more to accomplish these results that were previously in the public domain, because of the interdependency we must have to survive and to grow in the United States?

CALDWELL: I couldn't agree more. As a matter of fact, to me, if you understand the context in which I use it, I would say there is no such thing as large private enterprise. It's public. It's privately owned. But it's public, not governmental.

MEE: It's a horrible thought.

CALDWELL: We see this too in the leadership of large-scale corporate enterprises. This would include also large organized labor and professional groups. Leadership begins to see itself as charged with a public responsibility. The task we have, John, is to learn how to make this thing work, and to get our thinking, to a greater extent than it is today, tuned to the realities of the circumstances and to the necessity for it.

MEE: The results concept will let it work; with several interdependencies working toward the desired result, rather than the power.

CALDWELL: If we hadn't evolved this kind of a system, we would have had to invent it to do the things we want to do.

WATERS: If you have any questions, you may come up and direct them individually. I now will ask each one in closing to give their telephone number, in case you have any thoughts during the night.

END OF SESSION

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SESSION NO. 12

EDUCATION NEEDS IN TECHNOLOGY UTILIZATION

Chairman:
Harold Schuman
General Manager
Indiana Manufacturers Association

Moderator:
Richard L. Lesher
Assistant Administrator
NASA

Panelists:
Allen Kent
Director
Knowledge Availability Systems Center
University of Pittsburgh

Brig. Gen. J. M. Kenderdine
Defense Personnel Support Center

Paul E. Klinge
Associate Dean for Undergraduate Development
Indiana University

Robert O. Harvey
Dean
School of Business Administration
University of Connecticut

EDUCATION NEEDS IN TECHNOLOGY UTILIZATION

SUMMARY OF REMARKS BY HAROLD SCHUMAN

Mr. Schuman opened with the suggestion that in many ways this had been a long week, but it would be terminating today. During the Conference he said we have heard about the rapid change in technological developments in today's world. The focal point of our concern is that in the future the rate of change will be geometric rather than linear. If change is our focal point of concern, then education is the means of change. Consequently we must give serious attention to education, if we're going to deal with the effective utilization of technology, he said.

Mr. Schuman charged the panel with two questions: In what manner can the education system utilize the new technology to improve the process of education? By what means can the students be prepared or better prepared to utilize the new technology upon graduation, or even before graduation?

SUMMARY OF REMARKS BY RICHARD LESHER

Dr. Lesher suggested that this panel would be a "clean up" panel. Therefore, it might range across all of the topics that had been touched upon during the week.

Concerning the previous comments on management, he referred to a question posed by Mr. James E. Webb, NASA Administrator, at a recent lunch discussion: "How do you go about telling this story and getting business schools to teach systems management? How do you get the great academic community interested in what is taking place in the space program, particularly in management and economics?" One outgrowth of that discussion was the suggestion that it would be worthwhile to take people from the academic community around to NASA centers to see what actually goes on. Dr. Lesher said NASA had done just that. "They loaded up an airplane full of Deans; about 50% Deans of engineering schools, and about 50% Deans of business schools. They were taken to Houston, to Huntsville, and to the Cape. That was over a year ago and the only results of that trip have been some Thank You letters to NASA. There hasn't been anyone following up on it and making a strong proposal about getting into this area, of documenting the results."

Dr. Lesher then turned to the panel topic of education needs. He related an experience at one of the smaller regional dissemination centers with a number of very dramatic cases of technology transfer. A little over three years ago he had helped establish the center in Southeastern Oklahoma. One of its clients was a small company that was getting into the electronics business--just getting started. It had six employees and wanted to send two to Huntsville to go through the NASA soldering school, so they could be certified instructors in soldering. "When we were out there just a few weeks ago," Dr. Lesher reported, "we found out that this company, in three short years, has grown to a payroll of $875,000 a year. Within the next year, they will be about a five million dollar a year operation. The nucleus of the labor force of that entire company is those two instructors." This, he noted, shows the value of education at all levels in the combination of events that it takes to produce economic growth or industrial development. Dr. Lesher emphasized that one needs education, capital, and technology--both the "hard" technology and the management technology.

SUMMARY OF REMARKS BY ALLEN KENT

Mr. Kent first discussed the background of the Knowledge Availability Systems Center to indicate why one particular educational institution, the University of Pittsburgh, was interested in participating in the NASA technology transfer effort. The University, he said, has been increasingly sensitive to the problem of growth of knowledge at a faster rate than society can assimilate or use it. One place where a university finds overt evidence of this increase is in the library. The increasing storage requirements call for more and larger buildings. The use of materials increases to the point where more efficient "housekeeping" methods are needed to get books to publishers, to the shelves, off the shelves to users, and back on the shelves ready for the next user.

He said that another place where the university finds evidence of the knowledge explosion, is in the structure of the academic schools or departments into which interdisciplinary types of students fit only with very great pain; not only to themselves, but to the faculty and the administration. The response of the administration has generally been to establish new departments, new centers, new institutes, and new degree programs.

Mr. Kent emphasized that with these and other evidences of the knowledge explosion, it is becoming accepted that the problem must be coped with. He cited the increased teaching of principles rather than facts, as one method of bringing into managable size, the formal educational experience of the student. There is increasing reliance on the ability of the graduate to dig up the facts, which he can then hang on the intellectual framework he's acquired during his formal schooling, and during continuing education he said. It follows, then, that increasing demands must be made on the systems that will produce the facts and that will be needed to solve the problems that the graduate will have posed to him as time goes on.

But, he pointed out, for the most part, the speed of collection and ease of accessability to stored information often are more of a problem for efficient handling of modern knowledge than the volume of storage. There are indications that the existing apparatus for collecting and retrieving is already very sorely strained. He reemphasized the point made earlier by Mr. Mullis that there's a growing need to do more than just gather and house information; it must be actively disseminated to those who need and use it. There is clearly a need for the review of the mechanisms by which knowledge is treated; from the moment it is created as knowledge, until it is delivered to a user, he said. The University of Pittsburgh first addressed itself formally to these problems in September, 1962, he added, when Chancellor Litchfield, called for a study along four major lines: that new knowledge is transmitted too slowly; that its transfer depends on the inadequate equipment and technologies of earlier times; that knowledge in many fields has already become so vast and complex that, often, we do not know what we have or where to find it; and that there is need to examine the means for relating vast quantities of knowledge to one another, so that patterns may become discernable to the thinking, researching, practicing, professional person. This, then, was the atmosphere for the establishment of the Knowledge Availability Systems Center, he said.

Mr. Kent said that four years of work in such fields as logic and language, publication procedures, library and record storage, information retrieval, and media studies had led the Center to postulate a new role for the information scientist in society. In addition to upgrading the traditional function of this person as a caretaker of knowledge, Mr. Kent felt he should be charged with a new responsibility for actively disseminating and studying its use. Specifically, he said, the Center has three functions: (1) To conduct research on the development and evaluation of systems; (2) to operate new systems, and (3) to teach the use of these systems within the several disciplines and professions where they can be employed effectively. Faculties from the substantive areas of studies within the university contribute to the Center: philosophy, logic, linguistics, behavioral sciences, library sciences, industrial engineering, education, business management, and computer sciences. These have contributed to the design and evaluation of the work of its systems.

He identified resulting benefits. First, the transfer process, although very poorly understood, has become the "name of the game" in education. Involvement in the Center has enriched the graduate teaching program in information sciences. It has also helped in establishing a fine working relationship with industry.

Mr. Kent then turned his attention to how to accomplish individualized service within the university. For example, the total government report and published periodical literature would have to be indexed in depth, and stored in a form to permit intricate and rapid manipulation, so that effective individualized service could be provided. An attempt to do so would involve the individual university taking on the entire national problem, he said. On the other hand, it would be more economical to exploit the work of others by attaining the processed materials in appropriate form, ready for use locally, at a much more modest financial investment. Yet, there's no one national organization that centrally acquires and indexes the total store of information in a way that permits ready replication for most local uses.

He pointed to the proliferation of specialized information centers, many overlapping. The educational institution is, therefore, confronted with the problem of trying to align itself to properly exploit the national investment in information systems. He identified the following alternatives: First, adopt a wait and see attitude; second, adopt an opportunistic point of view, acquiring significant data stores ready for local exploitation; third, adopt an attitude of evaluating the total situation in information processing, acquiring the data stores that seem useful for the university's own purposes, and working toward coordination of these from a use point-of-view. He recommended pursuit of the latter alternative. He concluded that the NASA technology transfer program had helped us to recognize that transfer, while important with regard to aerospace, is critical with regard to the entire educational process.

SUMMARY OF REMARKS BY GENERAL J. M. KENDERDINE

General Kenderdine offered his views regarding the educational needs for logisticians. He felt that these people had been overlooked both within the framework of government and industry. He identified a new organization called the Society for Logistic Engineers, SOLE. It was started by industry in the aerospace firms and is growing very rapidly. One of the objectives of SOLE is to sponsor a Chair in Logistics at some big university in this country so that formal recognition can be given to logisticians, he said.

General Kenderdine suggested that logisticians are now at a fork in the road. One branch leads along the path of the last several decades, wherein logisticians are trained mainly through actual experiences in the various facets of logistics. The other branch opens up a broad horizon of highly complex, sophisticated logistical methods and techniques which require formal training. Obviously, this is a road we must take, he said, if we are to be efficient in the use and the application of logistics in the '70's and the '80's.

He identified one big problem as defining logistics. There is a wide difference between civilian logisticians and the views expressed in Department of Defense publications on this. The DOD publications generally point out that logistics is a military science, concerned with the planning and carrying out of the movement and maintenance of forces. He suggested that the problem of obtaining an overall definition of logistics--one that will be acceptable to the military and to commerce and industry--should be the responsibility of educational institutions working jointly with both civilian and military logisticians. The military, particularly in the years since World War II, and more definitely since the end of the Korean War, have tried to do something about the education of logisticians within the military, he said. They have had career courses, at such institutions as the Industrial College of the Armed Forces, the Army Logistic Management Center and the Defense Weapons' Systems School. Unfortunately, he said, many of the officers within the military establishment were never able to go to these schools, even though they were serving, and will serve later on, in important logistic assignments. He questioned the existence of any formal training programs orientated strictly to commerce and industry, in any of the universities and colleges of the nation. He alluded to many fine courses which touch upon logistics and which logisticians must know. But, he said, we have finally to come to grips with the problem of logistics and formalize an approach to logistics through education.

General Kenderdine then posed the question, "What can be done to provide the educational needs in technology utilization for logisticians?" He emphasized that logisticians are among the big users of technology. He called for the establishment of specific courses in acquisition of people and material, cost effectiveness, inventory control systems, distribution systems, contract management and administration, and operations research. He did not imply that operations research was not being taught; what he was calling for was courses strictly orientated towards the broad aspect of logistics. He cited The Martin-Marietta Corporation in Baltimore which recently made a good start in trying to solve the problem of adequate education of logisticians. It, in collaboration with the Johns Hopkins University

Evening College, has established a program leading to a Bachelor of Science in Logistical Engineering. But because neither Johns Hopkins or any other school could come up with a definition of logistics, it took more than a year to even begin to set up this program, he said. During the school year, 1963-64, two courses were offered. One was titled "Introduction to Logistics" and the other "Maintaince and Maintainability - Operations in Management." Unfortunately, at the end of the 1965 semester, the university, as an economy measure, dropped these logistic courses, he said. He also noted some hesitancy on the part of the logistic employees of The Martin-Marietta Corporation to spend the time on logistics engineering degrees, when they could get one in the same time, for example, in mechanical engineering or electrical engineering, which were more firmly established and have been recognized for many decades. Besides, he said, the latter careers drew the higher beginning salaries. He called this short-sightedness, because of his belief that the future horizons open up great opportunities for logisticians.

General Kenderdine then suggested two levels of education to solve the logistician's needs, one of these to provide technically trained technicians--that is, logisticians--and the other to develop logistic engineers proper. For the former, a two-year college program at the community level was suggested. A more comprehensive program could be established at the university level for the professional logistics engineer, with courses designed to develop administrative and managerial logistic concepts and practices, he said.

He then turned his attention to examples on the technology that logisticians are using today, particularly in Vietnam. He had within the past ten days returned from an extensive trip throughout Southeast Asia. The major portion of his time was spent in Vietnam, looking at the results of our efforts to support (from a food, clothing, and medical care standpoint) all of the forces out there.

> "For example, 30 miles south of the DMZ, in the north, at DaNang, I saw a really outstanding installation of a brand new IBM 360 with the Marines, who were using it and all the associated 'hardware' and 'soft ware' to maintain a real good handle on their supply support, their supply requirements and their maintainence requirements. Incidentally, most of the operators doing the work with this IBM 360 set-up were Vietnamese. All the key-punch operators were charming little Vietnamese girls.
>
> "Another couple of things...this is perhaps the first war that we've engaged in in the last three or four decades that we had the right kind of footwear and the right kind of clothing at the time the war started. It's true we didn't have enough of the right kind of footwear or clothing when the big escalation came along. The reason we didn't is that we didn't fund for it, and we didn't want to spend the taxpayer's money years ahead of time to have millions of uniforms and pairs of boots on hand, hoping that someday we'd have a war in an area where we could use them. But today we're using in Vietnam, a jungle boot that, to hear the enthusiastic compliments and comments of the people that are using them, is the greatest thing since sex.

"This jungle boot is a good application of simple technology. It's built very similar to the World War II combat boot; same configuration, about the same height and size, except for one radical departure. For a long, long time, we in the military and everybody--hunters and campers and outdoor people--have said that if you're going to walk in a wet environment, you ought to have waterproof boots. The civilian side made a fine, expensive waterproof boot. The military spent several millions of dollars making waterproof boots. But the best waterproof boot in the world becomes a non-waterproof boot, when you step in water over the top of the boot. Water comes into the boot, and it can't get out. Then you walk around in water until you can sit down and take your boots off and dry your socks and the inside of the boot. So, some smart guy, an engineer with a Ph.D. degree, said: "Why dont' we forget this? Why don't we let the water come into the boot and then provide a way for the water to go out?"

"We made a boot with a coarsely woven nylon fabric upper. We made a silicone-leather treated vamp. Then to that upper we vulcanized, or molded--we didn't stitch it--a composition rubber sole. Then in the instep area, on both of the boots, we put two port holes...two in each boot. These are brass port holes, kind of like grommets. They have a little brass screen on them. So you walk in the swamp or the rice paddy; you let the water come in through the top of the boot, through the nylon fabric, through the port holes, and you're walking in water. Then you get out of the water, whether it's an hour later, or a day later, and walk on dry land again; and in 30 minutes, your feet are dry; your socks are dry. Why? Because the bellows action of your feet and your instep squashed the water out of the port holes. Your body heat drives the moisture out through the nylon. Your feet are dry; your socks are dry. You have no jungle rot.

"This boot--everybody likes it. A very unsophisticated comment is, "you don't have to break these boots in to wear them." The nylon is not resistant and stiff like new leather is. However, the molding of the sole to the upper, unfortunately, wasn't an American process. It was a Swedish process. This boot, when it was first designed, was designed to be used only by the Special Forces in Vietnam--the Green Beret boys that have gotten so much publicity. Then it was very quickly realized by everybody we had there ought to be able to use these boots.

"So, when the big push came, there was a tremendous requirement for these boots. About the time the big push came, however, because of the anticipated initial very limited use of it, there was only one manufacturer in the United States that had the capability to make these boots. He had gotten the molds from Sweden to mold the soles, etc. But, very quickly, logisticians within the Department of Defense grabbed the ball. And today there are eight manufacturers that are in production on this boot. About seven more have the capability; they have the molds. But eight actually have contracts at the moment. The current monthly production of this boot is about 300 thousand pairs. About 3½ million pairs have been made to date. And there is ample quantity of these boots for everybody that we have in Vietnam, and any numbers that we would ever hope to put there.

"The other thing that shows great use of technology is the jungle combat uniform. This is a very loosely woven, cotton poplin. It's a very light weight poplin; about 5½ ounces to the yard. It was designed with some real technology use in mind. A very easy comfortable fitting pattern was used. It hangs loosely, and fits loosely on the person. It's not a very military looking thing. You wouldn't win any prizes in a parade, or be in the Queen's guard with it. But it's comfortable; it's cool. They don't even worry about a rain coat in the Monsoon rains; they just get wet. When the rain stops, in about 20 to 30 minutes, about the length of time that it takes your boots to dry, the uniform is dry.

"There's also a new operational ration. We still have a ration similar to the 'C' ration. This is called a 'meal, combat, individual', but it's far more sophisticated than the 'C' ration was. There are actually people over there that say they like the 'MCI' meal better than their regular garrison rations. We've got another one, which is called the 'ration of long-range patrol'. This is not a full meal; it's about a thousand-calory snack. It's packaged in a very simple thing that can be carried in the pockets. It's actually a flexible package. They can stuff, six or seven of these in the big pockets of the combat uniform. But the main thing about this, and the thing that was developed through the use of new technology, is a freeze, dehydrated component. To freeze any item after it's been cooked, and then dehydrate it, gives almost a perfect item for reconstitution. For example, in this new ration we've got 12 different menus.

"One of the best is chili concarne. It was prepared and fully cooked and then freeze dried under flash, real deep freezing conditions. By doing thus, we remove about 98.5% of all the moisture content. Then, it's a very simple thing to reconstitute it. We have it packaged in a little mylar bag--heavy mylar. When it opens up, it stands up. This is your cooking pot for reconstitution. You open it up and merely pour in water. If you're not ingenious enough to get some hot water--and there are very few soldiers that are not ingenious enough to get hot water--you could reconstitute it with cold water out of your canteen. Within three minutes after you pour in hot water, you've got reconstituted chili. In five minutes after you pour cold water in, you've got reconstituted chili. Here is something that real technology utilization made possible--freeze dehydration.

General Kenderdine said that we would see a lot of this food in the future. We have a little bit now, he said, citing Armour, which has been merchandising 2 or 3 entrés in supermarkets, which it advertises for hunters and campers.

He concluded by renewing his plea to give formal recognition to logisticians.

SUMMARY OF REMARKS BY PAUL KLINGE

Mr. Klinge reemphasized Mr. Schumans two points: education's needs for technological utilization, and the need for education in technological utilization. He referred to his responsibilities in undergraduate development, commenting that one characteristic of the world today is the fact that we're having a great deal of trouble with youth. That might also have been said some four thousand years ago, he noted but it's coming very, very close to home now. Riots in cities around the country indicate, and observers have shown, that the youth are involved in such rioting. One of the characteristics of youths today which has existed for centuries is that they are impatient with delays in getting changes accomplished, he said. Someone has said that they want tomorrow today. This is so apparent and is coming at such a great rate of speed that all in education, and now certainly government and business, also must pay attention to this intensive demand on the part of youth. They want action, and they want it now, he said.

However, in so doing they ignore many of the steps which most of us have to take in order to get from one place to another, he observed. He suggested a definition of technology utilization as getting from where you are to a better way of doing something. There are steps, and we want to know what those steps are, and if possible, how they may be speeded up.

Referring to the explosions of knowledge and of population, Mr. Klinge suggested that we are also having an implosion which is having a revolutionary effect on our society. We are reversing four thousand years of man's history, in which we have carefully built up organizational hierarchies and organizational filters through which people operate. Indeed, he said, we're tearing these down and are going in the opposite direction; and technology is accelerating this process. In other words, the youth of today want direct confrontations with "the guy who's making the decision." They want it now. This is the reversing of hierarchies of government, of business, of education, which we have carefully built up over many years.

Mr. Klinge pointed out that confrontation is made possible by all of the new means of communication. The term heard quite often in the last ten years is the "power structure." He suggested that businessmen would translate this into such things as labor unions or other organized groups, and those in government could understand it by such terms as the public, the voters, etc. Consequently TV and all the new communication methods have focused on just this point. This technological change, which has indeed changed our society has a great deal of implication for the whole field of education, he said.

Mr. Klinge then looked at education's needs in technology utilization. One obviously is "hardware", the hardware that goes with making education more efficient, faster, and available to greater numbers. In this category he referred to such things as computer aided instruction, audio-visual devices, etc. He emphasized the magnitude of the use by education of such "hardware" by quoting the National Science Foundation, which has asserted that in 1960 the expenditure by the so-called knowledge industry was 83 million dollars. In 1965, it was 251 million dollars. This increase for just 'hardware' indicates that education is very definitely interested in the utilization of technological improvements. He suggested that how well this is done, and under what conditions, is something that still needs to be studied.

The second thing he cited under education's needs was that we still don't know a great deal about how learning takes place; under what conditions, how fast, or what's the optimum method by which learning can take place. We know that it varies a great deal, he said. It depends on people, and is probably dependent on genetics. But, at least, learning is a process which we must deal with throughout our entire lives, no matter what our jobs happen to be, he noted. Some of the new advances in technology have helped in studying this very fundamental problem. Telemetry, for instance, enables studies, at least with animals, as to how fast learning is taking place. Here he introduced the problem of psycho-pharmacology; what are the influences of chemicals or drugs on how fast people can learn? Anyone who keeps abrest of the current literature knows that this is a popular area.

The third thing cited in relation to education's needs was: What are the effects of cramped environments on learning, on education; on what and how people do what they're going to do for a livelihood? He related this to cities and their crowded urban environments. He suggested that much of the news that we've read in the last few years is a function of cramped environment. The biologists have known this for some time, because of their studies of rats and mice and other animals in cramped environments, all sorts of changes occur; not only in the social structure of the animals, but also in their physical structure. Perhaps, indeed, we must face this right now as an educational problem, ignoring its governmental, industrial, social and cultural implications. The biologists have come up with a concept of territoriality, where every living type of animal organism, including man, must and does have some type of physical territory which it considers its own. When it is invaded, there are all sorts of changes that occur in man and in animals.

The fourth thing he cited as education's need was the organization of the educational system. We are in deep trouble on this point, he said. On the one hand, many people assume that putting up a new school is all that is required to take care of an educational need. He quoted one author as saying, "We might be heading for a whole set of intellectual slums." There is such a thing as quality and efficiency in education. While these are two very hard things to define, they are nevertheless always present and must be attained, or at least striven for, in such a way that simply the erection of new physical plants is not assumed to be the answer to educational needs. He said that in the organization of education, as the country grows larger and faster, the problem of bigness is one which is literally feared, and is always the subject of a great deal of criticism. Bigness in industry was a subject of criticism culminating in Anti-Trust Laws. Bigness in government was and still is feared. Bigness in everything seems to be feared, and yet, it is a component of our modern culture. Mr. Klinge said we have to figure out what is already known about big operations, such as DOD and NASA. This knowledge should be applied to the operation of educational systems while retaining the democratic component which, he said, we assume is absolutely necessary.

Mr. Klinge then emphasized the need for a much better way of job and vocational placement of the students in the educational system, no matter at what point they depart from the system. We are still using notices on a bulletin board--or the modern variation, classified notices in a newspaper. Even the person-to-person interview still being used goes back to before the days of Christ he said. There are many, many better ways of doing this. He said, "One of the problems in the riots is obviously joblessness. The joblessness of our youth is at its highest per cent. This creates problems because the youth don't even know which jobs are attainable." Here is one of education's greatest needs which, he said, requires some help from industry.

Next, he urged management help on the basis of what are the objectives that society sees in our education. The effective organization of higher education to utilize the brain power among the student body and among the faculty is a current worry, he said. We have been using very antique systems. The incentive system, utilized in industry, has a most productive way of getting something out of an individual. Yet, the incentive system is ridiculed in higher education for just this same point, he observed. For instance, it is often difficult to get a faculty man and an industrial concern together. There are rules and regulations imposed from outside the university system which interfere. There are internships by which some of the better graduate students, and some faculty members, work in industry for a certain period of time. How can higher education get itself organized in order to make a meaningful, two-way relationship? He pointed to problems such as the confidentiality of the service that business wants, and the demand on the part of higher education that research must be immediately made public knowledge.

Mr. Klinge stated that educational problems and needs are enormous. In this country we believe in something an ancient Greek said: "Only the educated man is a free man." If we really believe in freedom, then we're going to have to assume that education is a component which all citizens must have. This raises a question of a spectrum of ages; that is, we are trying to teach people under certain conditions, from an elementary grade all the way through the rest of their lives--continuing education. For instance, we cannot just simply kick kids out of school and say, "You can't measure up to our academic standards." These are the guys that start rioting, he said. We have to talk about the interests, and the span of interests, that kids have all the way through elementary to adult education; the interest in staying in school and learning new ideas, new trades, new occupations. Then we have to talk about how education fits in to the enormous breadth of economic, social and cultural backgrounds of the components of the educational system.

He concluded with the observation that education, at the present time, is an arm of national policy. However, education is not organized for this major task, which has been given to it in the last 20 years.

SUMMARY OF COMMENTS BY ROBERT HARVEY

Dr. Harvey focused on three points: surmounting barriers between disciplines; some ideas on an academic discipline on technology management; and the proliferation of published trivia.

On surmouting barriers between disciplines, barriers which impede concept transfers, he suggested that a discipline is a discipline because it has its own language. He pointed out that the languages of disciplines are often more unique than are the concepts within them. If we could find a means of breaking down the communications barriers, the transfers of concepts and ideas would occur far more readily. One way might be to work on the development of a thesarus of synonyms, of terms, of concepts, and systems, he said. This sort of thing has been undertaken with respect to engineering. A broader-scaled attempt that would go beyond engineering into all the other sciences was suggested. A second way of breaking down the barriers would be to develop a new "super" language of science and technology. A third way, and perhaps a more realistic way, is simply to begin stressing in teaching the need for inquiry beyond the disciplines.

Dr. Harvey then referred to suggestions from Dean Teare of Carnegie that we should teach the use of knowledge we already have in order to learn new things--concentrate on how to use what we know; second, that we teach people how to continue to learn after the termination of their formal learning situation; finally, that we teach how to use the literature in professional journals and information banks, which are not fundamentally related to their own areas of discipline.

Dr. Harvey then directed his attention to the question of an academic discipline of technology management. We must have more research simply to understand technology transfer and technology utilization, he said. We don't yet know enough about technology transfer or technology utilization to produce transfers where transfers and uses were not already present. It's fairly evident, he said, that we have been able to enhance transfers, that we have been able to increase the numbers of transfers in areas where the climate for transfers, the understanding, the practice of transfer and utilization, already existed. He referred to a panel on invention and innovation sponsored by the Department of Commerce, headed by Dr. Robert Charpie, President, Electronics Division, Union Carbide Corporation. The panel's basic conclusion was that the number one barrier to innovation isn't so much anti-trust action, taxation, or lack of capital; but ignorance of the forces that influence technological change. The lack of objective data, in or out of government, on the innovative process in general, and the technologically based firm in particular, is symptomatic of a very serious deficiency in our thinking regarding technological innovation.

The next question he raised had to do with the management of technological change, transfer, and use. In the early efforts of the NASA TU Program, James E. Webb had a concept about the role of the entrepreneur--the role of management and managers--which included managing transfers. Dr. Charpie's panel found that companies that are active innovators have managers with extraordinary abilities for grasping and managing technological change, he said. The firms that fall behind, on the other hand, have built-in barriers to change. Their managers have not learned how to utilize technological opportunities and innovative skills.

We know a little bit about management, he said, but not much about the particular way in which management relates to transfer and technology utilization. "We have aspirations of trying to work in this field at Connecticut. And at NERAC, we have a person on our field staff, in our table of organization, which we call the applications specialist. His aspiration is to work with managers to help bring about transfer and utilization." He suggested that this may result in the development of a department of technology management. This might be a department with the objective of developing graduate level courses in the area of technology management. He defined the field of technology management as interdisciplinary, including engineering and the physical sciences as the technical facet; sociology, psychology, and anthropology as the behavorial facet; and economics as its theoretical facet. The integration of these multiple facets for the effective utilization of technology by society is possible through the exercise of management, he said. Course content could include technology information and transfer systems; product development management; research and engineering management; economic considerations of technology innovation; project management; information science, storage and retrieval; and perhaps a research seminar in technology transfer. Many of these would be taught in conjunction with the department of economics, and the departments of engineering, he said.

On the problem of publication, he said that much of the transfer, retrieval, and storage--and particularly the access and retrieval problems--have to do with the proliferation, in print, of trivia. He suggested more critical pre-publication reviews. He identified two routes to scholarly contribution. One approach is that of the scholar to his peers, sharing with them his research in the most abstract and fundamental way. The second role is that of the scholar to translate his work for the benefit of the practitioner. If we can learn to recognize and give equal value, in the academic community, to the writings of the scholar who writes for the benefit of the practitioner, we may take a giant step toward increasing the transfer, he said. Dr. Harvey concluded with the observation that the contributions of scholars writing for practitioners is the one which should be far more important in determining and influencing economic growth in society.

DISCUSSION

<u>HARVEY</u>: General Kenderdine, is not logistics really an administration or management problem? The attention that you seek may very well actually be already in force, or could be developed to a greater extent, if you turn to the business schools with an administrative, managerial label, rather than to those with engineering with an engineering label.

<u>KENDERDINE</u>: This is one of the big problems of this thing as approached by educational institutions. The word engineering used with logistics is, in my opinion, as obviously in yours, a misuse of the word engineering. I quite agree that perhaps logistics and the science I was talking about could better be named logistic management.

Recently, I had lunch with some of the people from the University of Pennsylvania. This was one of the questions that was bothering them. Where would we put such a discipline? In the School of Engineering or in the School of Business? I said, that I believed that it belonged in the School of Business, because it fits into the framework of the thing. The only reason I used the word engineering in connection with SOLE is that this is the title that this group, fortunately or unfortunately, used when they put themselves together. But I don't think anybody in the business wants to carry a torch for the word engineering.

QUESTION: I have a question for Paul Klinge concerning the restrictions that were placed on universities that come from the business world. You hinted at the legislature and other government regulations. Could you detail those a little bit more?

KLINGE: The constraints which public universities face in this are a little bit different from the ones that private universities face. In the main, public universities have had policies--either internally or externally forced, but always pretty definite--that the work load of a professor is 'X' number of days and he is to be given a salary at an 'X' amount of money. Federal government plays along with this game by saying that if you get a grant or a contract to do work, which may indeed take much more than 'X' amount of days, which we assume is a normal load, you still will get the amount of money or the salary which has been set by the university administration. There is no extra payment permitted. This has indeed been true in many public institutions, regardless of what the man does; whether it's over and above his load, there still is only one salary involved. That is particularly true if the grant, or the fee, or whatever is run through university books.

Obviously, there are several ways out of this. One is to set what is called the normal load of the faculty member at less than a seven day week, or less than a five day week. And there are two very large public institutions, and very well known ones with high prestige, which have flatly said that they consider a faculty member's load to be four days a week; if he can't double his salary in that fifth or sixth day, then we don't want him around. On the other hand, most public universities have not been able to get by with that type of exit to this dilemma. The other one is to have all payments for extra work not run through university bookkeeping procedures. This creates all sorts of problems for deans who are supposed to find out and keep track of whether or not the guy's really giving us his full attention for what we consider to be a full load. Now, that's one of the primary problems. In industry we have an incentive system, and good work means more pay. This isn't necessarily true when you get into the university business.

KENT: I'd like to just indicate, in specific terms, how ridiculous the situation becomes with regard to this. I now can go out and hire, and pay through a contractor, a professor from an adjoining university. But I can't hire my own faculty because of that constraint.

COMMENT: I'd like to make a comment with regard to General Kenderdine's statement. In many schools now the Professors of Transportation are getting their titles changed to Professor of Logistics. This has happened at Stanford. I just finished writing a variety of them that are coming to a meeting here, and I asked how many had either shifted or were contemplating it. Of the 70, there were 19 who had already become Professors of Logistics. I think there were 30 contemplating the switch. But probably, they'll go to a new title that, in industry, is being used in place of logistics, and that is Professor of Physical Distribution. A whole series of companies now are turning over this composite of purchasing, traffic, warehousing, inventory control, under a man known as the Physical Distribution Manager.

QUESTION: The other day, Jim Mahoney told a little story, relative to your point of printed trivia, about the fellow who was having an awful lot of trouble getting his stuff published, so he went out and started his own journal. Now we know that a lot of our problems stem from this proliferation; not of articles, but of journals. Would you care to elaborate on whether or not your remarks are an incrimination of the societies for not policing their journals; or whether we lack a mechanism for keeping trash journals out of our systems?

HARVEY: It's a combination. The people in a discipline find that they can't get their articles in other kinds of journals, because these journals are orientated in some other way, or the editors of the journals are not sympathetic with what is offered. These people, with all apparent good reason, try to manufacture their own journals. If these journals get bought or otherwise supported, you at least have something of a market test. On the other side of the picture, there has been so much pressure within the academic community, that the way to full rank, and the way to recognition, is through print. The emphasis has been on publishing. I'm inclined to think that within the academic community people are so well conditioned they don't bother to read most of this stuff, unless they are interested in the manufacture of another opportunity for reply.

QUESTION: I wonder if part of the library's problem is not so much a matter of classification, indexing, retrieving, etc., as it is destruction. Much of the information that's preserved in our libraries is no longer of use to anybody, unless it might be to future historians. In which case, it should be removed from the libraries and put into archives, shouldn't it?

KENT: One of the problems in libraries is, of course, determining what are the criteria for destruction. This really has to be articulated by the subject specialist in the departments. Once it is put away, it is very expensive to review this material, to determine what should be destroyed. It's not just the date that determines if it's worth destroying. If the faculty now could be encouraged to earmark those publications that should go out of the library, I think the library scientist would be glad to get rid of them. But, I think, in general, there's not enough time for the academic person to review this material and tell the librarian what to do.

COMMENT: This may be the function of the specialized technical information center that Howard Batchelder was talking about the other day, where they do an analytic interpretative job. They dispose of the material that isn't qualified to go into the center, and only have material that they, as qualified professionals, believe is worthwhile in having at the center.

<u>QUESTION</u>: Someone asked the question the other day whether dissemination centers would grow in number and speciality; or whether they would reach a peak and then fall within some larger national super-structure. What are your views on the role and development of dissemination centers.

<u>HARVEY</u>: I can only answer in terms of that hypothesis. As we've structured ourselves, we're impressed with the importance of our being able to interface with the clients--rapid physical interface. Now, if this is true, if it works out that our contribution as a dissemination center is made best with face-to-face contact, it's quite likely that, over a time, a number of dissemination centers will tend to match some element of geography. I don't know what the right numbers are; nor am I prepared to say that our experience in New England is one which will be duplicated elsewhere. But if it be so, there probably will be a few more, and rightly so.

<u>COMMENT</u>: The word transfer comes from the Latin and means 'to carry across', which implies that we're dealing with a situation where we have more than one field; where something is developing in one field, and we have the problem of transferring it into another field. It seems to me that one thing we could learn from this is that, if you're going to have technology transfer, you've got to have people who are familiar with more than one field. If everybody stays in one field and knows about his own field, but doesn't know anything about anybody else's field, you're not going to transfer technology. This indicates that the broader the education that the man has, the better chance he has of getting something accomplished. It seems to me that we sometimes forget, in these days of specialization, the importance of broad, general liberal arts education. The more we know about more things, with a certain degree of competence, the more likely we are to succeed in this problem of transfer.

END OF SESSION

LUNCHEON

THE ROLE OF THE MEDICAL SCIENCES

Chairman:
Harrison Shull
Dean, Graduate School
Indiana University

Speakers:
Maynard K. Hine
Dean, School of Dentistry
Indiana University

Ralph W. Phillips
Research Professor of Dental Materials
Indiana University

Joseph C. Muhler
Research Professor of Basic Sciences
Indiana University

SUMMARY OF COMMENTS BY MAYNARD K. HINE

Dean Hine, referring to the interruption of his dessert, indicated that he and Dr. Muhler had decided "we don't really need it anyway, since the chances are that it would increase our dental caries index". On the subject of Technological Utilization, he quoted Martin Goldand, President of the Southwest Research Institute:

> "Technology knows no industrial boundaries. Science and technology are fluent commodities. And they will flow from space-oriented research and development laboratories with the same ease and facility that has always characterized the flow of new knowledge. The material advance made possible can serve an enlightened nation. And when blended with wisdom and humanity, new doors to a brighter future will be opened."

Certainly, this applies also to the health sciences, he said. Technological advances in many fields have been adapted to health care problems to the benefit of everyone.

Dean Hine cited examples such as NASA supported research on the physiological and psychological effects of artificial changes in the length of the day, due to the time distortion produced by transcontinental and inter-continental flights. This research may help in advising how best to distribute working hours per day he said. Computer techniques for enhancing television pictures derived from Ranger, Mariner and Surveyor Missions are applicable in several ways in medical areas. These include getting more useful information from x-rays, from photographs, from microscopic analysis of chromosomes, and from electronmicroscope surveys of nerve tissues, he said. The use of slowly rotating rooms helps determine the individual's perception of motion and his illusions regarding his physical position, hence contributing to better understanding of this basic function. Improved knowledge of motion sickness and superior anti-emetic drugs will evolve from this kind of research; a direct 'spin-off' of space research, he said. Telemetry units have been designed for cardiac monitoring of astronauts. These have been modified for use in hospitals in intensive care units. An electromagnetic flow meter originally developed for the missile industry is now being used at the University of California in Los Angeles to diagnose erratic heart action that otherwise might be missed. Radiometers developed in space programs offer the potential of developing a method of picking out a hotspot in an individual body that might be a source of a malignancy, therefore helping in the diagnosis of pathologic conditions he suggested.

Another 'spin-off' of technological research cited was a special dialyzing apparatus devised for use in molecular biology which has been modified to control the exchange of fluids and salts more efficiently in artificial kidneys. Effects of simulated weightlessness on bones have developed some specific information value. Immobilized animals, for example, have shown not only a 27% increase in calcium loss, attributed probably to a vitiamin C deficiency, but, more importantly, a marked reduction in the capacity of the bones to make up for this calcium loss he said.

Dean Hine stated that research in fundamental biochemistry is going to help the general population in many ways in the future, although the original intent of the research was far removed from the health sciences. He also cited a six legged, walking vehicle, devised to be used to explore the moon, which has been adapted as a walking chair for people who have lost their limbs or are otherwise crippled; A switch, developed to be operated by movements of the eye, was originally for space astronauts. This eye switch can enable a paraplegic to control a wheelchair without moving his body or his limbs. The same switch could be adapted for use in a page turner, or by some person who is completely handicapped. A very small micro-lamp that will go through the eye of an ordinary needle, originally used to illuminate dials in space ships, is now being used for exploratory procedures in medicine he said.

Dean Hine then discussed an application in dentistry. Many years ago, he said, a dentist tried to make a handpiece that would power a self-contained drill. He was unable to get it to be practical, because the motor that he wanted to put directly on the hand-piece was so heavy he couldn't handle it. Space research developed a small motor which was then adapted to the drill. Now, many dentists are using this device which is plugged into ordinary 110 volt circuits.

Dean Hine then focused his attention on economic growth, suggesting that the health sciences are involved in two definite ways. First of all, the health sciences utilize so much hardware that industries have grown up for the specific purpose of supplying hospitals, doctors and dentists with these new machines. Time was when the physician would make an examination and the diagnosis with the tongue blade and perhaps a stethoscope, he reminded; but now a physician would be completely handicapped without all the hardware that is being used in hospitals. I can remember, he said, seeing the physician go into his little pharmacy, take down some bottles and compound his own prescriptions. Now the drug industry has grown to the point where no physician bothers to compound his own drugs, and usually he doesn't even write the prescription for the details of it. The health professions are dependent upon economic growth in this field to supply them with what they need.

Then he called attention to the fact that the health sciences contribute to economic growth through a reduction in the number of restricted activity days, from people who were not well. There were actually 424 million lost work days because of illness last year. According to the National Health Service Survey, there were 18 million restricted activity days from dental conditions. There were about six million days lost to work because of dental conditions. A conservative estimate of the cost of this loss is in the realm of ten billion dollars he said. He also said that we should remember that, many days, a person goes to work when he doesn't feel very well. These figures don't include the loss of economic activity because of a person feeling sluggish, etc.

Dean Hine concluded with the suggestion that the health professions have contributed greatly to the development of economic growth in many ways.

SUMMARY OF REMARKS BY RALPH PHILLIPS

Dr. Phillips' remarks were in the general area of physical research in dentistry, with emphasis on the contributions by the basic sciences. His object was to relate a few of the salient programs and indicate the integration of basic science into dental problems. The oral environment, he said, is indeed a formidable one, with problems of real intrigue. For instance, he cited normal biting stress as high as 30 thousand psi on a single tooth and pH changes ranging from very low to very high during the normal intake of food, and the degradation of carbohydrates. The oral cavity is one that is uniquely designed for destruction in terms of corrosion, being warm, moist and filled with debris of all kinds, he said. He suggested it as the utopian system for the study of corrosion.

> "Today, you ate ice cream, immediately followed with a drink of hot coffee--an instantaneous temperature change on the order of 150 degrees, which can produce destruction to materials and tooth structure that are placed in the oral cavity. To me, it has always been intriguing that teeth, dental tissues and dental materials hold up as well as they do."

Dr. Phillips said that these conditions appeal to the fundamental scientist because he can have at hand a system which produces rather heroic demands upon his instrumentation for study and upon the data that he secures.

Industrially, he said, although the dental materials profession doesn't represent a major share in the annual gross product, the profit is generally good. The market is small, but the mark-up tends to be high because of the tailor-made materials and services that have to be rendered to the patient. One example he illustrated was an Army program: the development of portable x-ray units for dentistry. A very small unit was developed by a group of industrial firms for use in the field. It does an admirable job, and conceivably will be utilized as a routine machine in the dental offices, as well as under service conditions.

One of the problems that the services face is the identification of casualties. Dr. Phillips said dental means provide one of the best methods for such identification. Using the computer, it is possible to take a full-mouth x-ray of incoming personnel and store this information in the computer. If that patient happens eventually to become a casualty, and one fragment of the mandible or of a tooth is available, they can then x-ray this segment of the tooth or bone. This can then be fed back into the computer and the results are rather amazing in the accuracy with which this person can be pin-pointed out of the millions that might be stored with the computer. Another use of computers he cited involved the photograph of a model made from an impression of a patient--a patient for whom artificial dentures are going to be made. The model is photographed topographically, as is done in high altitude flying. This can then be scanned by the computer. With the stored information and the proper jigs, one can actually mill-out an artificial denture.

Dr. Phillips then referred to an overwhelming body of knowledge which indicates that dental restorations do not seal the cavity. Isotope techniques have shown the penetration down along the interface between the restoration and the cavity walls, which accounts for such things as post-operative sensitivity, recurrent decay, marginal breakdown of the filling material, etc. This has given rise to a great interest in the possibility of designing adhesive molecules, he said. The implication goes far beyond simply filling a tooth. One could envision that, if someone could truly develop an adhesive cement, it might be possible to attach orthodontic wires or brackets directly to the tooth, without placing a band on each tooth. He suggested that this could change the whole practice and concept of orthodontics. It would change also some of our concepts about preventive dentistry and periodontal disease. He proposed the development of an adhesive film, the application of which might actually prevent or inhibit the formation of plaque material, thereby inhibiting the possibility of caries. It is conceivable, he said, that such a film could actually be a retarding mechanism for the formation of calculus, and would thus change the whole practice of periodontal disease. The development of adhesive molecules offers a very fertile field for investigation and for many practical utilizations, he said.

Dr. Phillips dwelled further on the adhesives problem. Indiana University assembled people in polymer and surface chemistry, and tooth structure, to discuss the problems of the oral cavity as they related to adhesion. At the end of this three-day dental conference, proceedings with recommendations were published. As a result of this conference, there was created an advisory committee on bio-materials. One of its functions is to implement and review research in this particular field. At the present time, he said, about a million dollars a year is being spent on fundamental and applied research with the ultimate goal of developing adhesive molecules for use in dentistry. One big problem is that the tooth surface, after the dentist prepares the cavity, is not only wet; it is inhomogenous, rough, and it is covered with very tenacious debris at a microscopic level. The nature of this debris is unknown, he said, and there are scientists that are trying to define more accurately and characterize the chemical composition of cut-tooth structure, the nature of the debris that lies thereon, and the best ways for removing it.

Laboratories which are synthesizing compounds that might show adhesion to the tooth structure include The Epoxolite Corporation, The Harris Research Laboratories, a subsidiary of the Gillette Company, and the 3M Company, he said. For instance, the 3M Company has been interested in the exact surface energy of enamel and dentine and how this energy may change after preparation of the cavity, he said. The surface energy is important to fundamental adhesion; the higher the energy, the better the possibilities for a molecule putting down and staying there. The surface energy of dentine immediately after the dentist cuts the cavity is surprisingly high he said. But in a matter of a second or two, the energy drops way down. This is probably due to contamination, maybe by air and other debris of the surface, he said. But the energy that is optimum at the time the cavity is cut is no longer optimum after a few seconds. This opens up the possibility, he said, of an approach whereby the dentist, as he uses a coolant in preparing the cavity, might include in the coolant some type of an adhesive molecule which would sit down on that surface at the time which it is receptive to it.

Dr. Phillips' final reference was to the barnacle. The barnacle is an interesting system in terms of adhesion, he said. The barnacle sticks under worse conditions than are necessary for adhesion in the oral cavity. There's no reason at all why it should stick to a rough, dirty ship hull under adverse environmental conditions. The Navy spends about 750 million dollars per year getting rid of barnacles he said. Very few people have studied why the barnacle attaches itself so tenaciously. This is the other side of the coin, and a very interesting one, he said. If one truly understood the mechanism of adhesion and the composition of the cement that the barnacle lays down, it might be possible to synthesize a comparable compound for use in the oral cavity he suggested.

The Goodyear Company, he said, working in cooperation with two scientists at the University of Akron, is seriously studying the nature of the secretion of the barnacle. It is very resistant to most solvents. The only thing that will apparently dissolve the cement from the barnacle is hot acetic acid, which doesn't pose a real problem in dentistry, he said. It is resistant to temperature changes as low as liquid nitrogen, and up to about 650^{o} Ferenheit. It has an excellent shelf life. The barnacle can be opened two years after it dies, and the cement is still liquid. It polymerizes, and a polarization reaction apparently occurs as it hardens. It occurs very rapidly under water, occurring in 20 minutes.

Looking at motion pictures of the life-cycle of the barnacle, one observes him transverse a surface, being very selective as to where he sits down to live for the rest of his life, Dr. Phillips said. Many scientists wonder why he doesn't stay here. Why does he go some place else? What's the nature of that surface that he seeks that might give a final clue as to the fundamental mechanism involved? But there are others who say that he really isn't that smart. The reason that he doesn't stay in one place is that he walks around until he finally gets caught by his adhesive. If it takes him longer than two minutes to get away from that spot where he's squirting out the cement, he's there for the rest of his life. So it may not be that he's selective, Dr. Phillips said. Other sea animals, such as the sea cucumber, do the same thing. But the barnacle has been studied in greater depth, and there is pretty good information on his life-cycle. Dr. Phillips said he selected the barnacle because it is one of particular interest to him.

Dr. Phillips identified other workshops which have been held and programs unfolded to relate the role of saliva in all the diseases of the oral cavity. Another one has been held in the general area of neurophysiology as applied to dentistry. Another entire program on the dental pulp, and the effects of conditions upon the pulp, drafting the competence of people in physiology, circulation, etc.

He concluded that dentistry is one of the few areas of the health sciences where contract research has been implemented and in which scientists, inter-disciplinary in nature, have been enticed into dental research and have made this a major segment of their activity.

SUMMARY OF COMMENTS BY JOSEPH MUHLER

Dr. Muhler opened with the suggestion that dentistry has a real economic problem and a real economic solution to the problem. He identified his objective as to show what the American taxpayer, the government, the state, and individuals face in terms of a solution to oral disease, and what Indiana University is doing to solve this problem. If one is only partially conservative in his estimates, he said, dentistry is just now coming into economic consideration, in terms of the contributions it can make to the food industry, to the metallurgical industry and to the automobile industry.

First he discussed tooth decay. The first recorded organized effort against the problem of dental caries was probably an Act passed on August 4, 1934 by President Roosevelt, governing the entrance of young men into the WPA work camps, he said. In order to enter these work camps, you had to, among other things, "have 12 teeth, 6 of which hit each other." These dental requirements were maintained until the Wagner Act was passed by the 77th Congress, which governed entrance into the Armed Services. The dental requirements were: "have 6 anterior and 6 posterior teeth." This is the same thing as the Murray Act except that dental nomenclature was used.

Dr. Muhler said that, of the first 2 million young men drafted under these specifications, more were rejected for failure to meet this dental requirment than for all other combinations, including illiteracy, put together. Forty per cent of the first 2 million men had to go to the dentist for immediate relief of pain. Five per cent had no teeth at all. He said that, in 1952, it was estimated that for the Armed Forces, which then had about 3 million men, they were collectively losing a little over 2.5 million teeth per year. Citing testimony taken from the United States Surgeon General, United States Public Health Service, 89th Congress, he said that 100 million Americans have never been inside a dentist's office in their lives. Forty million Americans go to the dentist only for the relief of pain. By the age of 35, 1 out of every 5 Americans needs false teeth. By the age of 55, 1 out of every 2 American needs false teeth.

Dr. Muhler then discussed major health centers that are being planned. As a result, he predicted that in 20 years there will be no metabolic diseases; diabetes, malignancies, cardio-vascular and cerebreo-vascular disease will be greatly diminished. This is an immense contribution, especially to the indigent part of the American population, he said. Even those that aren't indigent will benefit, he said, because the treatment centers will be vastly different from what we have in our medical centers today. He predicted that 25 years from now, the average man will be living 4.7 years longer, and the average woman, 6.8 years longer--70 years for men and 74 years for women, all with no teeth. He suggested that it doesn't make sense to say that we're going to make these advances at the expense of dentistry.

Dr. Muhler said that dental expense accounts for 17.7% of the total medical cost in the United States for in and outpatient care, including health insurance. Of the present 4.8 billion dollars medical expense, the dental portion represents more dollars than required for the treatment and prevention of cardio-vascular disease and tuberculosis combined, he said.

That's dentistry's portion of the health dollar, or, he suggested, perhaps it is dentistry's inability to answer that portion of the health dollar.

Next, Dr. Muhler related statistics from rural areas in southern Indiana. Four thousand families were surveyed. They had total annual incomes of less than $1,800. The average family size was 6.7 members. Eighty per cent of these people had never been inside a dentist's office. Of 85 children examined, 59 had never been inside a dentist's office. In the age group over 56, there were 204 subjects, 166 needed false teeth, three had false teeth. In Brown County 749 children were surveyed in grades 1 to 10. Of those 749 children, 741 had active dental caries. Eight had no caries at all. Of the 741 who had caries, 637 had never been inside a dentist's office. Of those 104 who had been to the dentist, 83 went there simply to have teeth removed.

He qualified the next problem as unpleasant to many, and one he did not wish to make more unpleasant. Forget the color of the skin he said, and look at it from a school teacher's standpoint. In Fort Wayne, Indiana they were running a dental caries study in 1962. The young man doing the clinical exams was a particularly conscientious young man. He was quite concerned about people; quite aware that the person in his dental chair was a human being, not a set of teeth. "This young man called me one night in New York at 3:00 in the morning. He says, 'Muhler, we've got a problem here in Fort Wayne with these children. There's no restorations in any of their teeth.' I said that was to be expected. Fort Wayne was the second city to flouridate its water supply. It had now been flouridating for 16 years, and you should see less cavities. He said, 'Well, I don't see any less cavities, but we see very few restorations.' Well, we programmed some of that data, and here's just a portion of it. Of 935 individuals whose skin was black, between the ages of 8 and 15 years; there were 3,466 cavities. There were 688 missing teeth. And roughly 2,000 needed to be extracted. In all those people, there were 119 amalgam silver restorations. Those 119 silver restorations were in seven people. 96.3 per cent of those black human beings had never been inside a dentist's office in their lives. I could ask the question if they wanted to go to a dentist, who would take them?"

Next Dr. Muhler compared the number of dentists to the population. In Thailand there are 270 dentists for 25 million people; in Indonesia, 400 dentists for 95 million people; but the United States has 1 dentist for every 2 thousand people he said.

Dr. Muhler then focused his attention on what dentists do in their offices. "I believe with every fibroblast in my body that in my lifetime, we will see the end of tooth decay," he said. He also said that this can be achieved on a nation-wide basis, without cost to the patient or without cost to the government. About 600 dental offices were examined. Daily office records for an entire year were photostated and analyzed. Two sets of data were presented, one for dentists who lived in an area where there was flouride in the water, and who practiced some preventive dentistry. The other group of dentists lived in a non-flouride area, and did no preventive dentistry. The amount of silver restoration was 400% less frequent in the area where there was preventive dentistry. There was a difference of 1700% in the number of teeth extracted. There was a difference of 250% in the number of dentures made. There was an increase of five-fold in the amount of gum diseases treated. He suggested that dental students should become more concerned about learning treatment of diseases of the soft tissue, to anticipate the time when there will not be dental caries.

The cause of tooth decay is food, he said, not carbohydrates. Every known amino acid, protein, lipid, carbohydrate, including dietary sweeteners, form acid in the oral cavity. Sucrose forms it even more rapidly. No human being, regardless of how sedentary or non-sedentary his occupation, need eat more than 2,000 calories a day. The mass of people need not eat more than twice a day. Certainly the frequent ingestion of food leads to more tooth decay, he said.

He illustrated the importance, from an economic standpoint, of fluoride in community water systems. This is the cheapest, on a population basis, the most effective and the least toxic of any preventive dentistry procedure that exists. For instance, he estimated, if Bloomington would fluoridate its water, it would cost each family from 4 to 15 cents per person per year. Or, in a life-span of some 67 years, this total cost would be less than the most simple restorative material. In a life-time, by putting fluoride in the water, you would not spend as much as the cost of one amalgam restoration he said.

For emphasis Dr. Muhler discussed an incident involving a tank at the 38th parallel during the Korean war: "I asked General Shira, why the 'dickens' didn't this tank fire on these people coming up the hill. He said, 'Well, that's a funny thing. You know, there were two people in that tank and one of them had a horrible toothache. The other one took the one back to the first aid station, at which time the enemy came up there.' Now my plea for a practical solution to this is communal fluoridation, because there is every evidence to believe that if that boy who had that toothache had lived in an area where there was fluoride in the water, he would not have had a toothache."

Continuing on dentistry Dr. Muhler suggested that we will be able, in a few short years, to provide the indigent groups with a ready-to-eat breakfast cereal, that will significantly reduce tooth decay, and significantly reduce the amount of radiostrontium accumulating in the skeleton. Think what it would be like, he said, when the day comes that we can buy a cereal which will significantly reduce tooth decay, and in all probability, result in less radiosarcoma of the skeleton and less leukemia. He said that we are beginning to know more and more about what happens to a particular phosphate ion, which is the principal active agent in the cereal; where it goes in the skeleton and what it does in the skeleton.

To illustrate what a simple, over-the-counter, ready-to-eat breakfast cereal could do for the potential of economic health he pointed out that one person in every 14 thousand in 1950 had the chance of having radiosarcoma. One person in every 11 thousand now has the chance of having radiosarcoma. One person in every 22,000 in 1950 had the probability of having leukemia. One in every 1,250 now has the probability of having leukemia or other similar related blood diseases, although between 1955 and 1961 there was a plateau in the radiostrontium level in the United States. Since 1961 the curve has begun to increase because Red China and France apparently detonate neutron bombs in the atmosphere. Dr. Muhler said there seems to be no way that we can reverse this in either Canada or the United States.

Dr. Muhler presented evidence to show that the radiostrontium fills a particular position in the skeletal molecular structure. Those who are interested in what can be done to plug that position occupied in the skeleton so that it can not be occupied by radiostrontium feel that you have to develop some mass techniques to do it he said. He suggested sucrose, sugar or a ready-to-eat breakfast cereal, as reasonable vehicles. It is interesting to us, he said, that a particular phosphate added to the cereal goes into the position normally occupied by radiostrontium. Hence, when one ingests radiostrontium in the water, the air, the food; instead of strontium going into the skeleton, it now finds that place occupied and is excreted. This looks very simple, in retrospect. Certainly when these data are published and become more available, further fascinating research areas in skeletal dynamics will be explored, he said.

Dr. Muhler then focused his attention on progress toward a solution to dental caries. He pointed out that Indiana University played a major role in the development of Crest toothpaste. He said: "I would not normally use that word. I would refer to it as the stannous flouride, calcium phosphate dentifrice. But on this campus, I'll call it Crest toothpaste. For those of you who come from other universities, I still will adhere to this position. I lived through the days when Herman Wells was called upon to tell the National Council of Catholic Women that Professor Kinsey could do work on this campus, and that they didn't have to send their kids here if they didn't like this. But as long as he was President, this type of work was scholarly. While he did not receive the same type of pressure with Crest toothpaste, Dean Hine knows that there was a lot of economic pressure brought to bear upon President Wells and the Board of Trustees to give others, other than Proctor & Gamble, the license to use this formula. One of the real things which this administration has done is to provide presidents like President Wells and President Stahr, and Deans like Dean Hine to give nuts like me the opportunity to work unrestricted. I'll say publicly, in Dean Hine's presence, in the 20 years that I've been working for him, never once has he told me what not to do. He's told me what to do many times, but not what not to do.

"I've put on this slide just the formula of the dentifrice for you to look at so you can see there's nothing mysterious. There's a thing to clean your teeth, which used to be called the abrasive. Now we call it a polishing agent, and I'll show you why. There's a soap. Working for Proctor & Gamble, this would of course be a detergent. I don't know what a soap is any more. There is an agent to make this soft, so that it comes out of the tube after a year, usually glycerol. There is a binder to hold it together so that it doesn't run off your tooth brush. That's all a dentifrice is."

Dr. Muhler pointed out that use of this formulation resulted in 30% less tooth decay. The average child who brushes his teeth 7/10 of a time a day will have roughly a 25% reduction in tooth decay. These benefits can be extended to the adult population he said, whereas communal fluoridation serves only those people, under the age of six, who are permanent residents of the community, and who drink from the community water supply. Take the children in an area such as Bloomington, where there's no fluoride in the water, and clean their teeth with a prophylactic paste that contains fluoride; paint their teeth with an aqueous solution of fluoride, and give them a fluoride dentifrice. This will result in roughly 66% reduction in tooth decay, he said. But this requires coming into the dentists' office or clinic every six months. It would require about an hour and 40 minutes every six months at a cost somewhere between $15 and $30, depending upon a variety of factors; and you could see probably six people a day. But, he said, you could significantly reduce tooth decay for all classes of the people. By using fluoride in the water, fluoride prophylactic paste and topical fluorides in Crest, 83% reduction in tooth decay can be achieved, he pointed out.

To the above treatment Dr. Muhler would add a new abrasive which really has the ability to thoroughly clean and polish teeth. None of you have ever seen your teeth clean, he said. A new polishing agent and some hand made chemicals, have been developed by studying what goes in and out of the skeleton, in terms of the molecular size of the atom being replaced, and its valence, etc. This compound, stannous zirconium hexafluoride, was synthesized from basic science knowledge he said. For application he suggested taking all the children in an entire school, lining them up in the gymnasium, getting the local dentist or hygienist to direct, and having volunteer mothers pass out this abrasive, and the children brush under supervision for two minutes. It will result in roughly 100% reduction in tooth decay, he said. This would require no expenditure of funds by the patient or the state he said.

Dr. Muhler then showed some clinical results at the end of eight months in Spencer, Indiana: "Spencer, in many peoples' mind is a horrible place in which to live, from a school standpoint. The homes are widely spaced. The money problems of getting children into the school system because of the area involved is difficult. The tax rate is very low for the school budget. The kids demonstrate this, because their mouths are simply terrible. We lined all the kids in Spencer up in the gymnasium four years ago, and gave them a self-administered treatment of an anti-prophylactic agent, which required roughly four minutes and seven seconds to treat about 1,400 kids. At the end of eight months, there was not a single child that had a new cavity. At the end of three years, there was not a single child that had a new cavity. Total treatment time for three years was 14 minutes and 14 seconds." This, Dr. Muhler said, is mass control of dental caries.

Next he discussed some army sponsored experiments at the Michigan City, Indiana, prison. The use of the new prophylactic paste was compared when a dentist applied it twice a year, when a dentist applied it once a year, and when a prisoner applied it himself. There was about 90% reduction in new caries in adults, when the prisoners applied the treatment themselves. If you look at the data hard, you will see that actually the numbers are better when the prisoners did it than when the dentist did it, he said. He also cited Navy data. At the United States Naval Academy in 1960, there were 17 dentists spending roughly $400 thousand dollars a year on dental materials he said. Today, there are three dentists in Annapolis, spending less than $50 thousand a year on dental materials. In 1960, the average Midshipman had three new cavities per year. The average Midshipman now has one cavity every seven years he said. Think of this in terms of simple materials and dollars, multiplied by roughly two million men in the military today he said.

His next challenge he called something about which Indiana is really proud. There are over 1,000 students on this campus this fall who will be here because of Crest royalties. Wisconsin can also be proud, having taken the proper attitude toward the use of the Steinbach patents for Vitamin D., he added. "I would like to have you search all the Foundations in the world and find which has made better use of research dollars than to turn them back into student scholarships. I think the administration at this school should be greatly complimented for this. There are over 1,000 young boys and girls, next September, that will be on this campus, because from Foundation funds, mainly contributed by Crest tooth paste, it is possible for them to go here."

Next Dr. Muhler discussed a new dentifrice. He said the major reason we lose teeth is not because of tooth decay but usually from gum diseases. He said he has now developed a dentifrice which will significantly reduce caries, about four times as effectively as Crest. At the same time, it reduces the hard deposit on your teeth called calculus he said. To dramatize the cleaning qualities of this product he showed before and after pictures of an army enlisted man. The "before" picture showed how the young man's teeth looked after the Army had tried to remove the stain. They were still a dark green. This young man said he'd never brushed his teeth. The Army had bleached his teeth with hydrogen peroxide, and then polished them with a soft stone all to no avail. The "after" picture showed his teeth after just one brushing of zirconium silicate, administered in a little rubber cup by a hygienist. The teeth were white. Dr. Muhler said the young man was given a mirror, and he started crying. "I went up to him and said, 'Well, what's the matter with you?' He said, 'Well, I've never seen my teeth clean.'

Dr. Muhler concluded as follows: "The second part of our economic story is that we treat people. America is built on people. The thing that we have to do is give serious consideration; we as a university have to give serious consideration, to the problems which face the mass control of dental caries. We need to do it as a free enterprise system. We need to do it before the government does it, because someone has to take care of these people. I believe Indiana is well on the road to provide some yardstick for the three major causes of oral disease, as far as tooth decay and periodontal disease go, in that we have mass treatments available. We have every aspiration to believe in the next five years, if properly planned, all children in the United States can receive for the first time some benefit of preventive dentistry, because all children, even the Amish, go to school.

"Secondly, we believe that we can make some contribution to the nutrition of these young children. A cereal is just the beginning. If you knew as some folks at Indiana do, what's coming in terms of preventive nutrition, you would share some of the thrill that we have. Lastly, we think we can make some contribution to the cosmetics, which is the typical reason a dentifrice is used. You will see in the next year or two, a lot of increased interest on the non-therapeutic aspects of dentifrices. We hope that we're in tune with this, and abreast with it, and that we can keep, hopefully, a step ahead of competition in this area, which is now exceeding 600 million dollars a year in consumer sales, for just one product, a dentifrice."

CONCLUDING STATEMENT

Paul J. Grogan
Director
Office of State Technical Services
U. S. Department of Commerce

CLOSING REMARKS BY PAUL J. GROGAN

OSTS has as one of its operating tenets that it seeks to work with educational institutions, technical and professional societies, industry associations and organizations, and our companion governmental agencies at local, State and Federal levels in the discharge of the over-all OSTS mission, without overlap or gap, while bringing the best available resources to bear upon the problems identified through State Technical Services programs.

The subject of how an organization conducts itself at the interfaces with its counterparts in society is becoming of great interest to everyone. We see the time-honored jurisdictional boundaries becoming obliterated in these dynamic times. The multi-disciplinary and systems approaches to problem solutions are being heralded for their successes in applications where the individual disciplines and fields of specialization have failed. Yes, either have failed outright or have short-changed society because of the inadequacy of their approaches, to say nothing about the long-term utility of their solutions. These arguments alone are compelling reasons for any organization, particularly a new one, to seek out and coordinate with its interfaces.

The role of the Federal Government as the manipulator of nearly one-sixth of the national income is held suspect by some in the private sector, although the example of "creative federalism" as evolved over the past three decades and as practiced today may indeed be misunderstood by many of the detractors of the Federal effort on behalf of the common weal. For where else is the generator, the stimulator, the moderator, and the monitor of the gigantic and complex economic engine that churns within our society and presently carries us forward at the rate of "one Manhattan project" per month?

Moreover, the immensity, almost beyond comprehension, that represents our national economy is mirrored one-sixth scale or in hundred billion dollar terms by the Federal establishment. Therefrom arises the need to identify and coordinate with all discernible competition throughout the Federal Government as a first round priority in the elimination of duplication.

Duplication of services between parallel commercial airlines and between automobile manufacturers is looked upon as the prime stimulus behind the competitive forces that carry us forward to our position of foremost wealth in the world on a national basis; a wealth that becomes all the more evident when computed on a per capita basis. But duplication of services by Federal agencies imposes not an equivalent, customary and debatably acceptable <u>one-sixth</u> drag--but an equivalent <u>two-sixths</u> or <u>one-third</u> drag--upon the particular sector of the economy being served not once but twice by the well-intentioned but overlapping or redundant services.

The example was cited this morning of OSTS and NASA/TU organizations operating side-by-side in a particular State, but I ask you to examine how different our respective roles are:

1) There are nine NASA/RDC's; there are potentially 54 STS organizations.

2) The RDC's have loosely defined regional responsibilities, whereas STS operates generally along State lines and under an instrumentality of the State.

3) The RDC's have a definite body of literature and services to sell to particular types of business organizations interested in and capable of applying space-age technology; the STS organization is concerned with business and industry generally--and all of its needs--having reasonable relationship to the acquisition and use of science and technology only a fraction of the needs of which are informational.

We find it convenient, satisfying and productive in Washington to cooperate with the NASA/TU program in some two dozen ways that we have identified in response to questioning by Congressional Committees. We trust that similar cooperation will evolve at State levels whereby the particular capability of NASA/TU and NASA/RDC's can be made an effective resource for the specialized information needs of the State programs.

OSTS is not only determined, but it is also required by its enabling legislation, to avoid wasteful duplication of services being offered by interfaceing public agencies at Federal, State, and local levels. It is also mandatory that we avoid harmful duplication of services being offered by the private sector. The latter form of duplication has its own built-in alarms, for no taxpaying enterprise will long endure in silence the unfair competition of the bureaucracy. But unthinking silence on the part of two or more Federal agencies operating side by side in the field of endeavor, like two benign but unknowing pachyderms harvesting all of the greenery in the Garden of Eden, is a specter to haunt both taxpayer and bureaucrat alike.

It is for these several reasons that we have addressed particular attention to the matter of knowing our interfaces with kindred agencies, as well as the avoidance of duplication with their services and programs.

The State Technical Services Act provides an opportunity, particularly to universities, to serve industry in a narrow corridor between their normal academic responsibilities and outright consultation. This corridor is the normal operational area of the extension arm of the institution; be it engineering, industrial, or general extension.

The technical service activities of <u>information</u> and <u>referral service</u> suggest an expanded and improved technical and scientific library capability not at all uncommon in such institutions. Moreover, the <u>field services</u> or <u>industrial liaison activities</u>, <u>demonstrations</u>, and <u>educational programs</u>, even as related to the acquisition and use of scientific and technical information, are normally available through the extension arms of educational institutions. This has been particularly true of the Cooperative Extension Services and should pose no problem for the "industrial extension service" now made possible under this legislation.

The discussion of the basic role of the State Technical Services in achieving the objective of economic growth as stated in the title and objective of your conference gives further indication of the potentials within this program under its national mandate. It is reasonable to expect that the objectives of this program will be both broadened and strengthened through time as the States continue to exercise initiative and imagination in the planning and operation of their individual programs and relate these lessons to both the executive and legislative arms of the Federal Government. This latter possibility of a new mandate in the technology utilization effort impresses me as being the route by which the adaptive technology that was discussed so much this morning might be performed.

This possibility would provide a very much larger role for the research institutes and consulting organizations in the over-all technology utilization effort in our country. When such work is undertaken, the obstacles now present in the administration of OSTS in terms of requiring one-to-one matching funds and the generally recognized lower indirect cost rates appropriate to technical services could very possibly be removed.

The greater problem, of course, is the fundamental issue itself whether or not such developmental work should be supported and, if so, how should the proprietary rights be disposed of that are almost certain to ensue from such effort. These unresolved issues may be an area in which some of you profitably could afford to spend some time thinking over the next several months. It is more incidental than coincidental that our legislation will be up for amendment during that time.

Now by way of closure, we in OSTS have benefitted very materially through this meeting by having been associated with so many representatives from State Technical Services programs at State and local levels and from the principal interfacing agencies of NASA, AEC, NRC, and SIE. But all of these are people we have come to know and respect in the regular processes of our work. This national conference has provided an additional opportunity to learn and grow by acquaintanceship with economists of national stature, a present member of the Congress, a principal resource person to a Congressional Committee, representatives from the schools of business and engineering, and distinguished experts in urban administration, financial institutions and business firms.

We owe a debt of gratitude to all participants in the discussions--whether from the platform or from the floor--for their contributions to our greater understanding of our role now found to be in common purpose with so many others.

I am sure Dr. Richard Lesher, Assistant Administrator of NASA for TU purposes, and Federal co-sponsor of this program with our own office, shares generally the sentiments I have expressed.